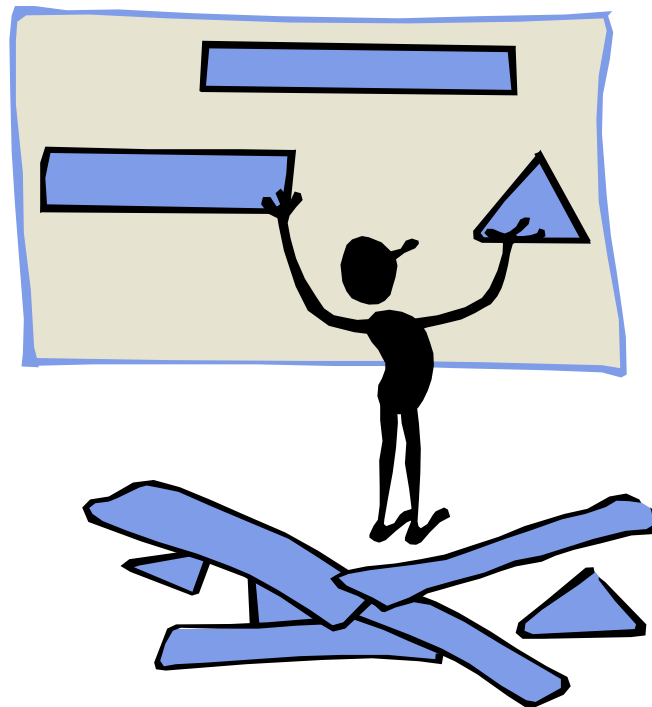
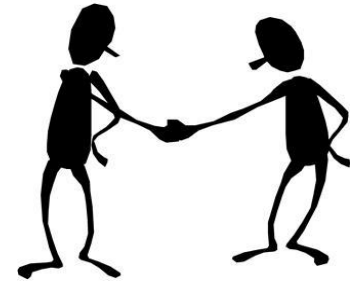


CHC Theory and Cross Battery 101



Credit



- Dr Kate Jacobs and Ms D Watts, Raise the Bar Psychology

Presentation March 21st 2014: “Advances in Cognitive Assessment: Cross-battery assessment and learning disability diagnosis”

- Dr Kevin S. McGrew, Institute for Applied Psychometrics (IAP)

<http://www.slideshare.net/iapsych/chc-theory-101-introduction-to-big-picture-context>

<http://www.slideshare.net/iapsych/chc-theory-codebook-1-cognitive-definitions?related=1>

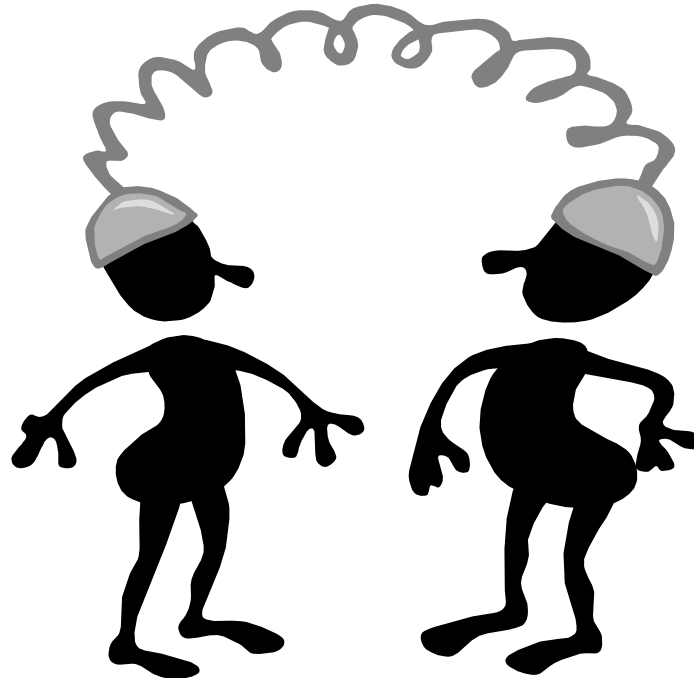
<http://www.slideshare.net/iapsych/chc-theory-101-from-general-intelligence-g-to-chc-theory>

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- McGrew, K. (2009). Editorial: CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research, *Intelligence*, 37, 1-10.
- Schneider, W. J., & McGrew, K. (2012). The Cattell-Horn-Carroll model of intelligence. In, D. Flanagan & P. Harrison (Eds.), *Contemporary Intellectual Assessment: Theories, Tests, and Issues (3rd ed.)* (Chap 4, p. 99-144). New York: Guilford.

References

- <http://www.slideshare.net/iapsych/pushing-the-edge-of-the-contemporary-cognitive-chc-theory-new-directions-for-psychologists>



Learning Objectives

Depends on where you are on the continuum.....

Some outcomes:

- Expand and/or deepen your understanding of cognitive abilities
- Review some of our more common assessment tools within this framework
- Explore the Cross-Battery Approach to assessment
- Consider and reflect on application of learning to practice

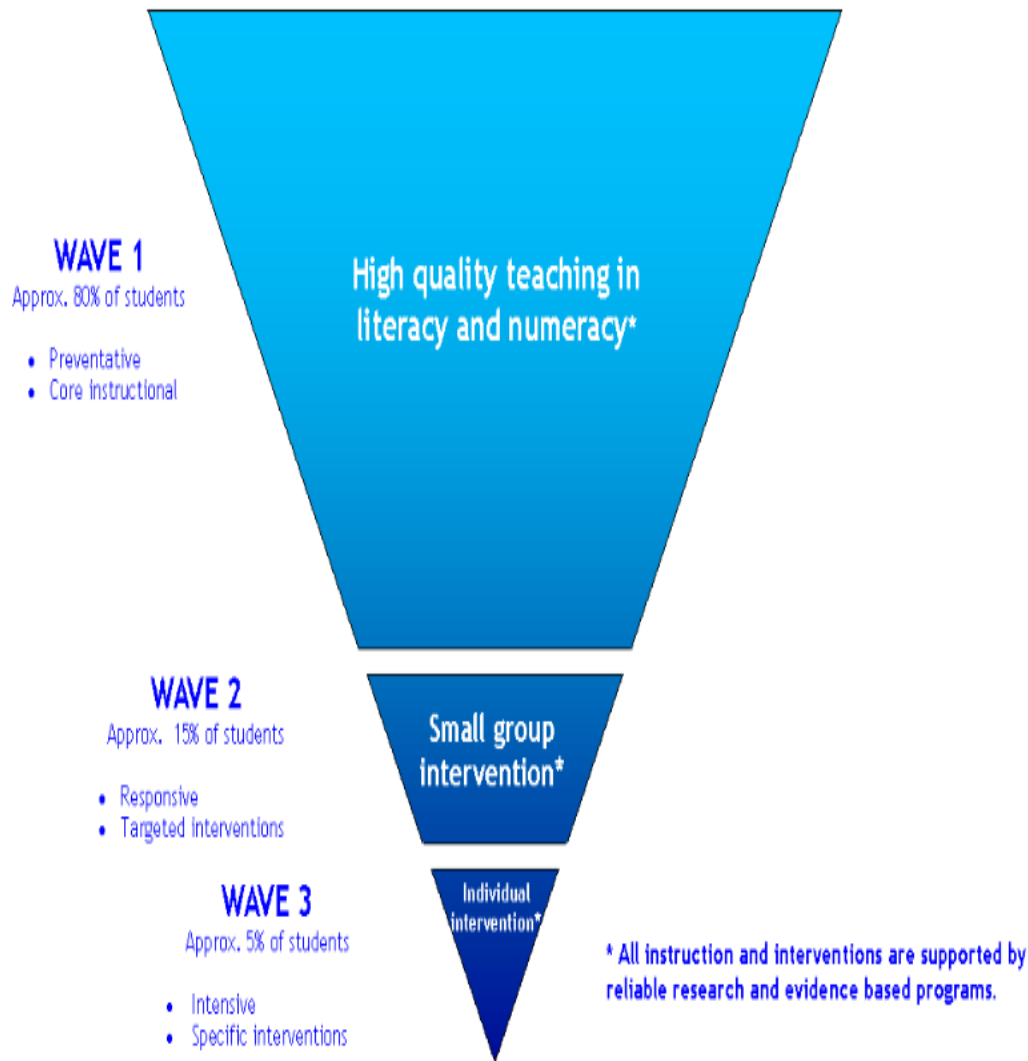
Session Outline

- Context
- Brief review of Intelligence and Intelligence testing
- The CHC Model
- Familiar assessment tools within the CHC model (WISC-IV in particular)
- Cross-Battery assessment (XBA)



"Mr. Osborne, may I be excused? My brain is full."

THREE WAVE RESPONSE*

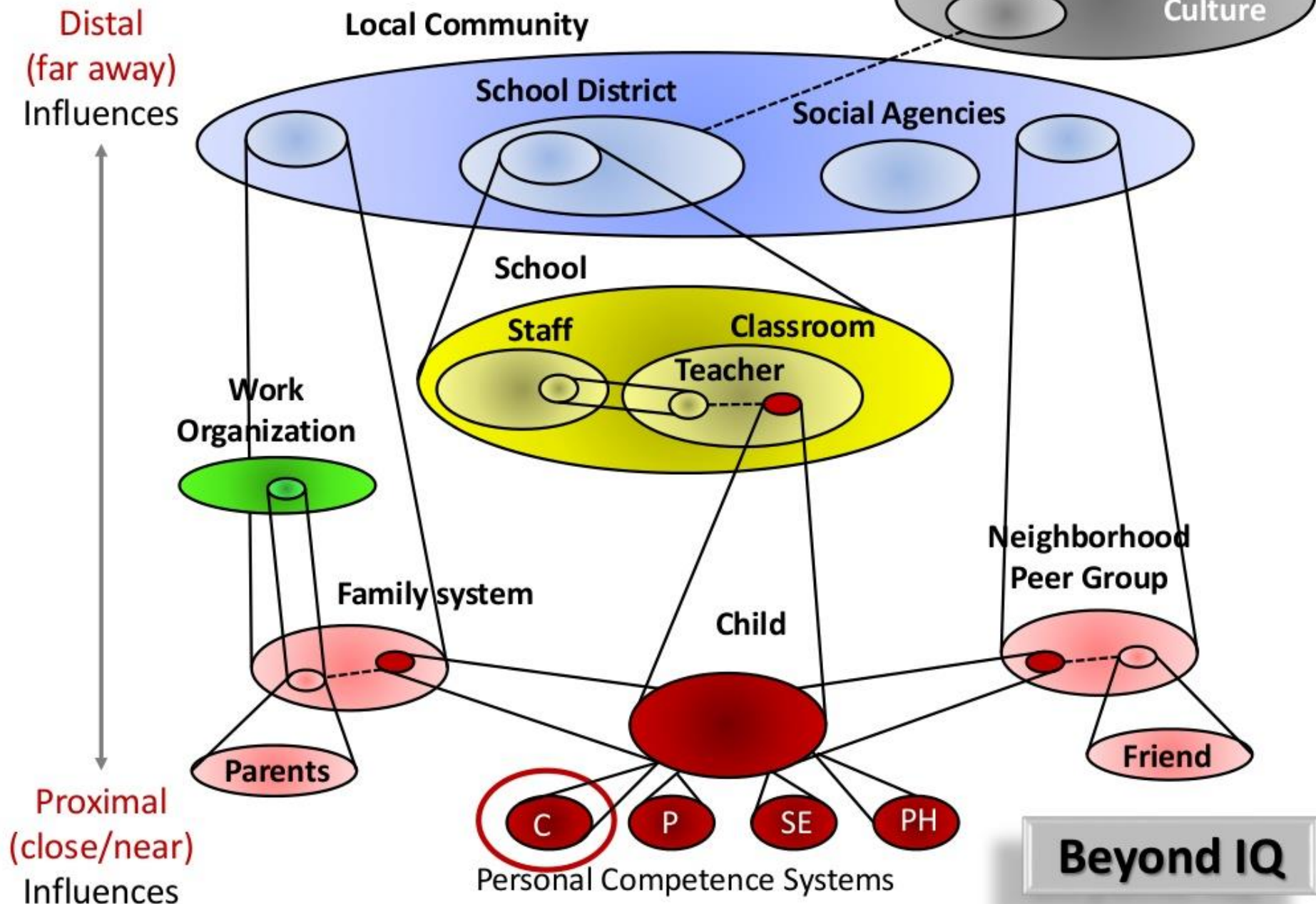


School Psychologist Role:

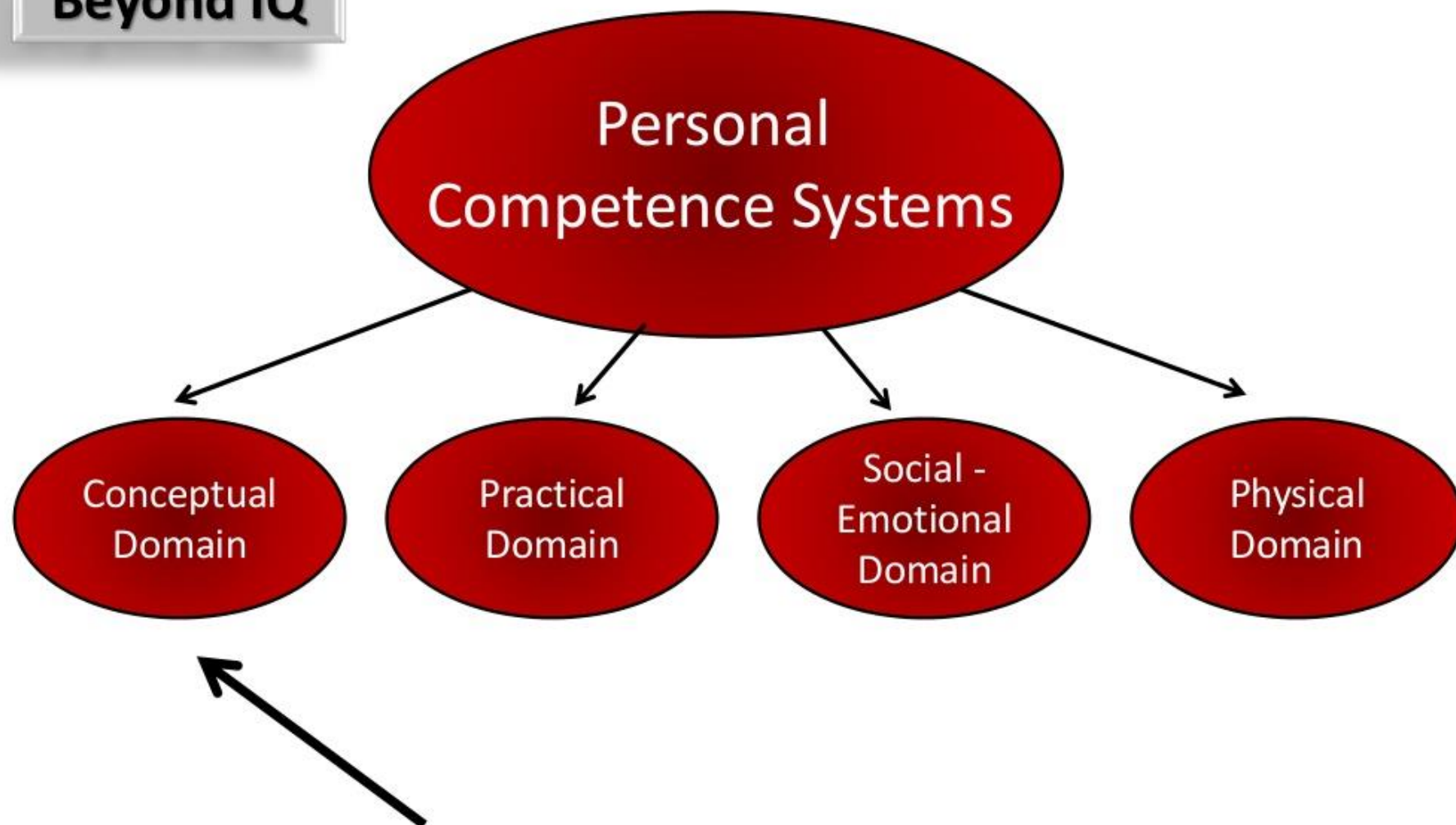
First Wave: SPs can assist schools &/or teachers with **decision making** around evidence-based instruction, screening, and progress monitoring.

Second Wave: SPs collaborate with general and special education teachers and support services personnel to **design** and **implement** effective, evidence-based **intervention** strategies.

Third Wave: SPs have a role in **conducting assessments** for the purpose of diagnosis and informing an individual educational program.



Beyond IQ



Cognitive and achievement batteries **sample only a portion** of a child's total competencies

A major purpose of psychological testing



- To appreciate the personal **individual difference “terrain” or “landscape”** of each person’s abilities.
- Understand each person’s **unique personal profile** (e.g., ability mountain peaks and valleys).
- Measure and identify each person’s **peaks (potentials, exceptionalities, capacities, strengths)** and **their valleys (deficiencies, weaknesses, deficits, weaker abilities)** in order to design educational programs to allow them to reach their fullest potential or capabilities.

An interesting thought.....

- ...the individual tested makes an unspoken plea to the examiner, not to summarize his or her intelligence in a single, cold number.
- ...the goal should be identifying hypothesised strengths and weaknesses that extend well beyond the limited information provided by FS-IQ, that may lead to practical recommendations that help answer the referral questions. *(Kaufman & Lichtenberger, 2006, p.415).*

An interesting notion....

- Spearman felt that the tests from which his *g* had emerged "had no place in schools" because they "deflected" teachers', pupils', parents' and politicians' attention from the business of education which, as the Latin root of the word implies, should be concerned with "drawing out" whatever talents a student may have.

KEY MESSAGES



“Tests do not think for themselves, nor do they directly communicate with patients. Like a stethoscope, a blood pressure gauge, or an MRI scan, a **psychological test is a dumb tool**, and the worth of the tool **cannot be separated from the sophistication of the clinician** who draws inferences from it and then communicates with patients and professionals”

Meyer et al. (2001). Psychological testing and psychological assessment. **American Psychologist**

© Institute for Applied Psychometrics (IAP) Dr. Kevin McGrew 4-25-14

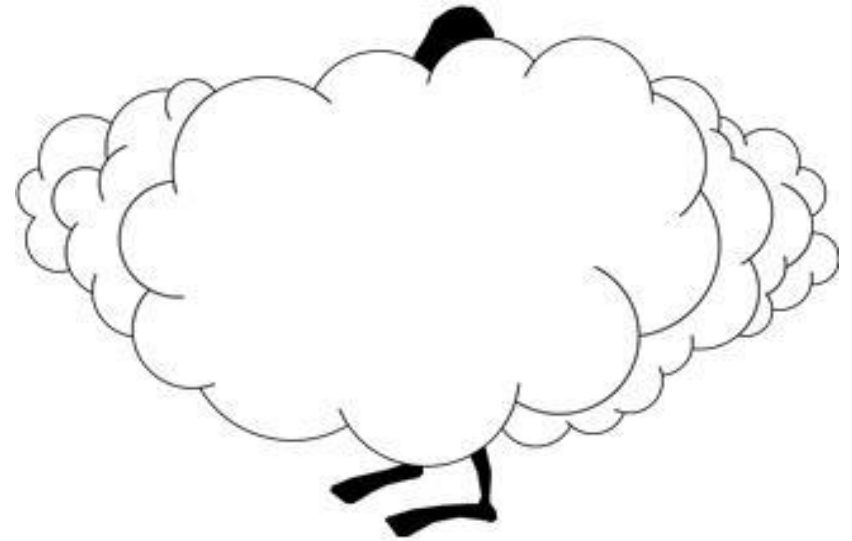


Assessment occurs for the benefit of the student and to inform school planning adjustments.

A Brief History: Intelligence Testing

John Horn compared the process of classifying and categorising human abilities and intelligence to “slicing smoke”

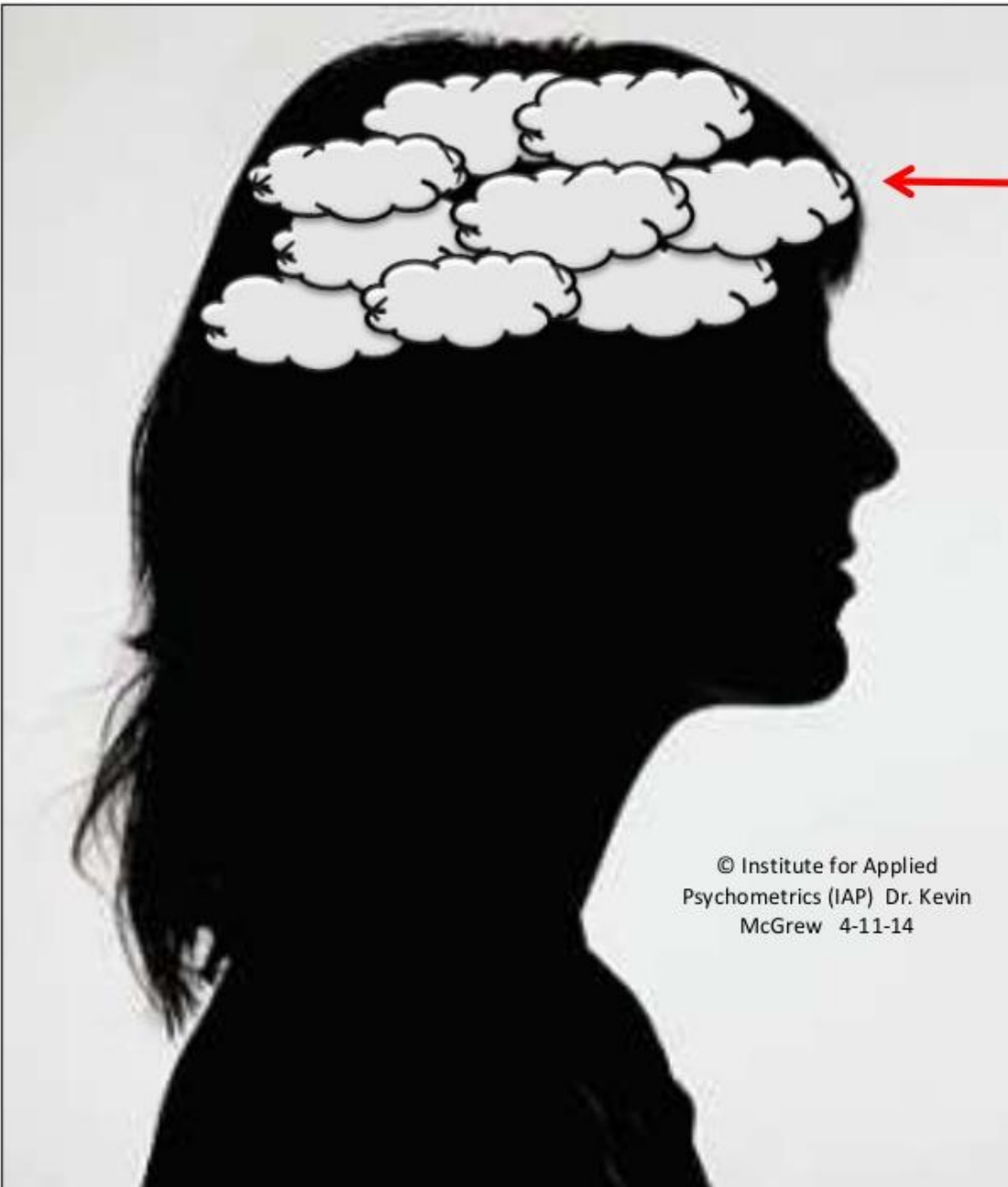
(Horn, 1991)





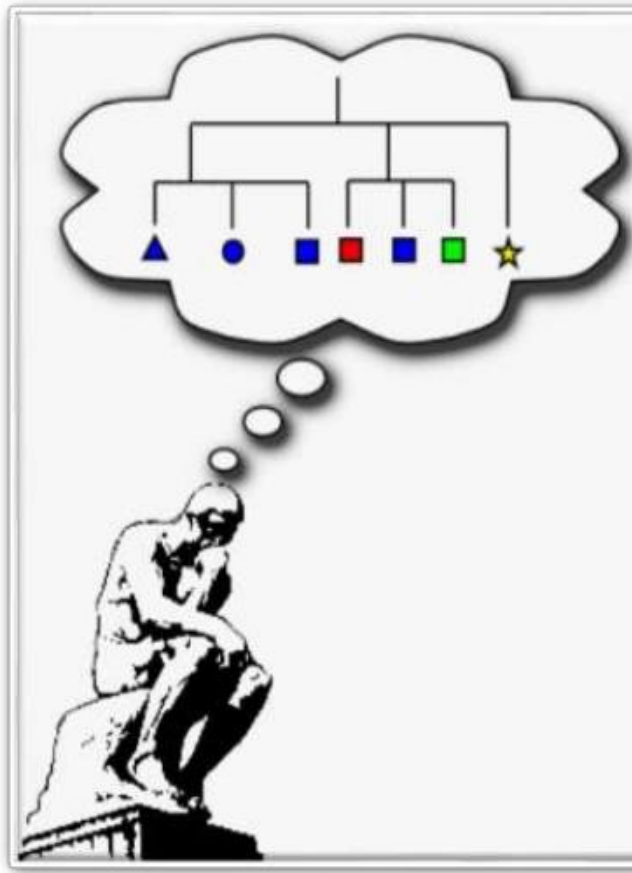
Human cognitive abilities are **hypothetical constructs**

- Hidden attributes
- Unseen phenomena
- Not visible
- Not directly observable
- Latent
- Are used to explain behavior



© Institute for Applied
Psychometrics (IAP) Dr. Kevin
McGrew 4-11-14

The importance of **taxonomies and classification** in science

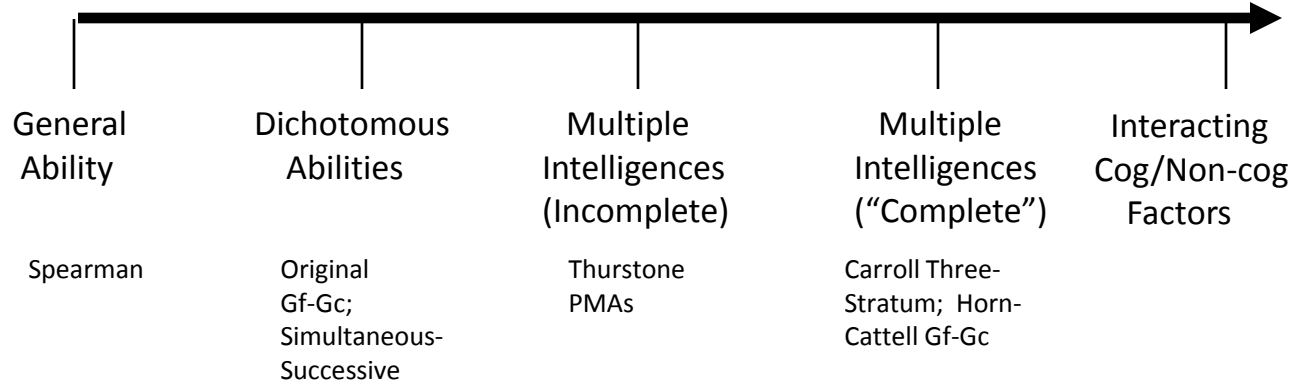


Classification is arguably one of the most central and generic of all our conceptual exercises...without classification, there could be no advanced conceptualization, reasoning, language, data analysis, or for that matter. social science research (K.D. Bailev. 1994).

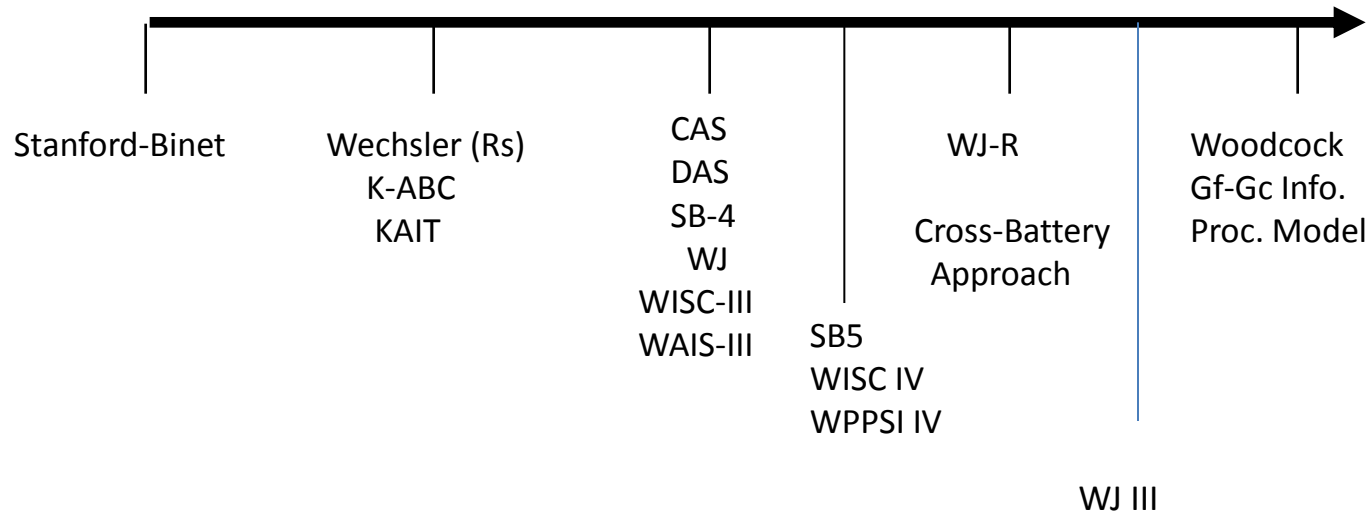
A specialized science of classification of empirical entities known as taxonomy (Bailey, 1994; Prentky, 1994) is ubiquitous in all fields of study because it guides our search for information or truth.

Modern understanding and assessment of intelligence

CONTINUUM OF PROGRESS IN THEORIES



CONTINUUM OF PROGRESS IN MEASUREMENT



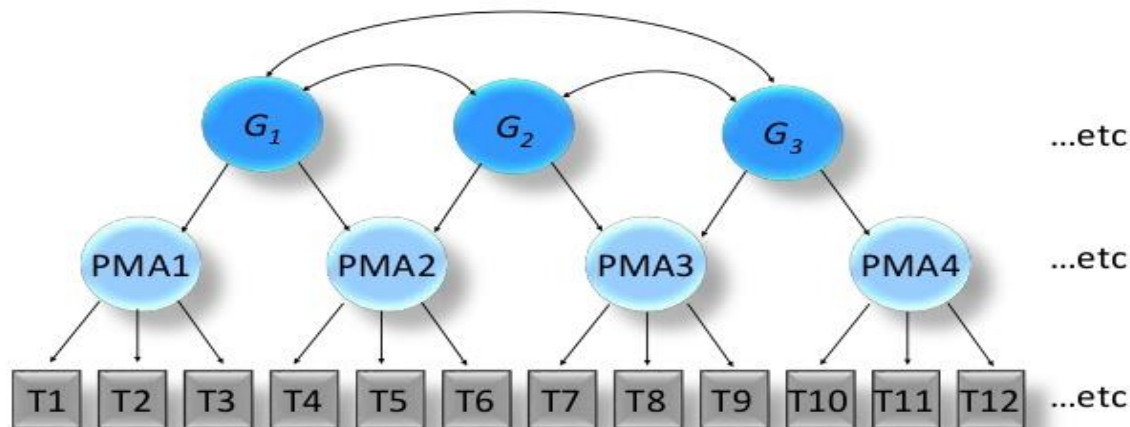
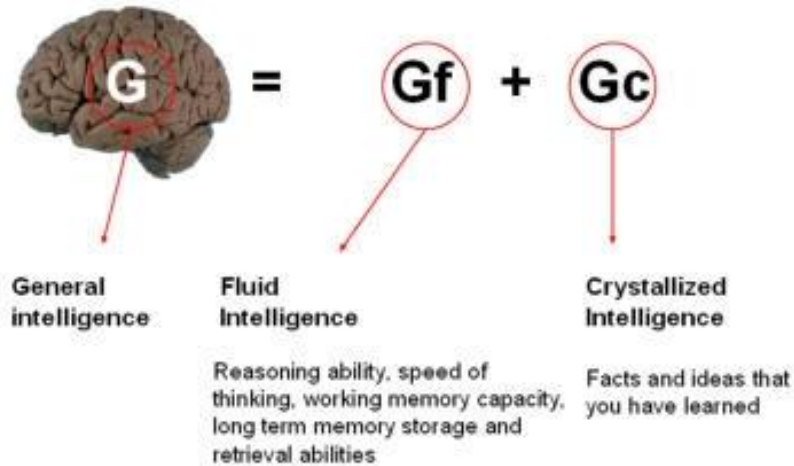
CHC THEORY

CATTELL-HORN-CARROLL (CHC) THEORY



Horn-Cattell Gf–Gc theory

Raymond Cattell



John L. Horn

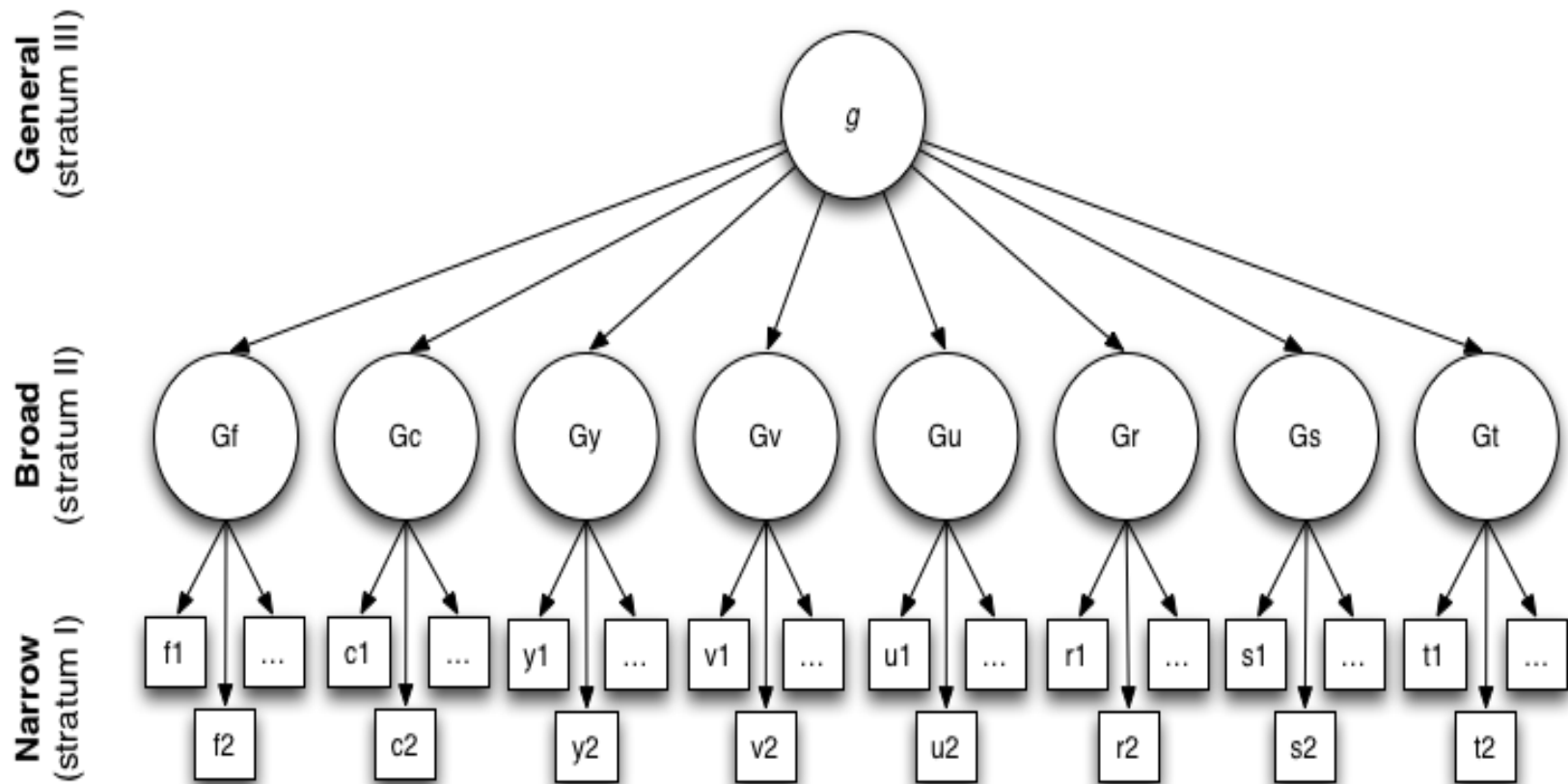
Cattell-Horn Gf-Gc Hierarchical (no g) Model

Limitations of Gf-Gc Theory

- It is largely a descriptive empirical generalization of research findings rather than a deductive explanation of these findings.
- The model structure is a result of factor analytic rotations of empirical factors and is not likely a good indication of the organisation of abilities.
- A theory derived from linear equations (i.e. factor analysis) is not of a form that well describes natural phenomena.
- It provided few details about how abilities develop or how cognitive processes work together.
- It is STATIC rather than DYNAMIC

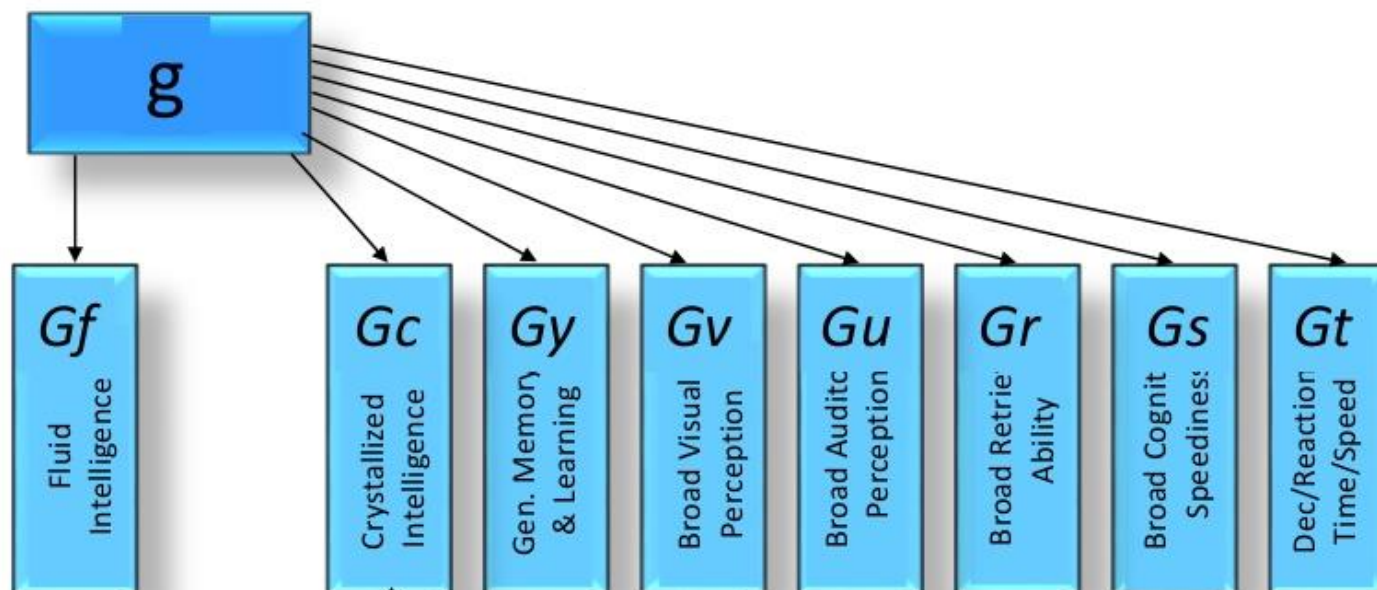
(Horn & Noll, 1997)

Carroll's three-stratum theory

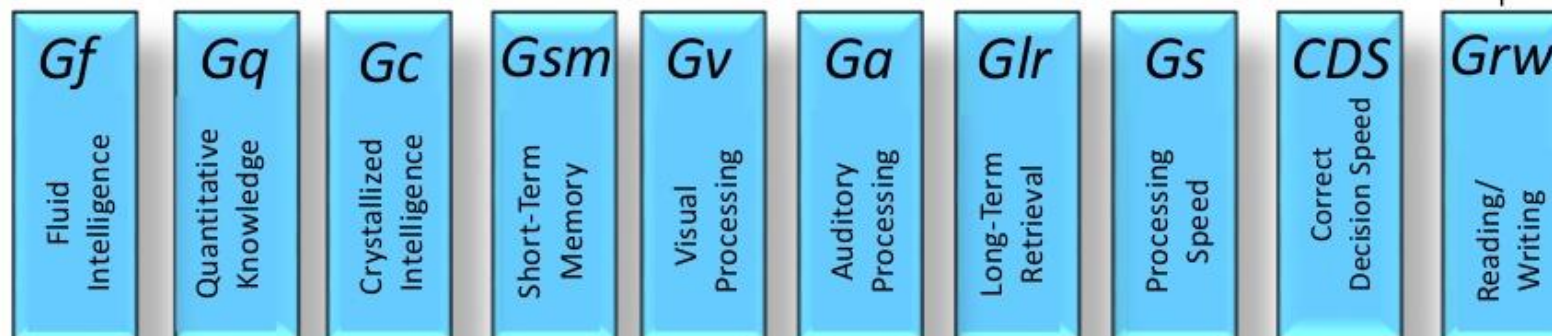


Carroll and Cattell-Horn Model Comparison

Carroll



Cattell-Horn





Contemporary
psychometric
research has
converged on the
Cattell-Horn-Carroll
(CHC) model of
cognitive abilities as
the **consensus**
working taxonomy
of human
intelligence

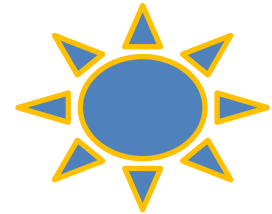
Seminal article

Intelligence 37 (2009) 1–10



Contents lists available at ScienceDirect

Intelligence



Editorial

CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research

Kevin S. McGrew*

Woodcock-Muñoz Foundation, University of Minnesota, United States

Highly cited article –
excellent overview!!!

ARTICLE INFO

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John Horn

John Carroll

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Gf–Gc theory

Cattell–Horn–Carroll Theory

CHC theory

ABSTRACT

During the past decade the Cattell–Horn Gf–Gc and Carroll Three-Stratum models have emerged as the consensus psychometric-based models for understanding the structure of human intelligence. Although the two models differ in a number of ways, the strong correspondence between the two models has resulted in the increased use of a broad umbrella term for a synthesis of the two models (Cattell–Horn–Carroll theory of cognitive abilities—CHC theory).

The purpose of this editorial is three-fold. First, I will describe the CHC framework and recommend that intelligence researchers begin using the CHC taxonomy as a common nomenclature for describing research findings and a theoretical framework from which to test hypotheses regarding various aspects of human cognitive abilities. Second, I argue that the emergence of the CHC framework should not be viewed as the capstone to the psychometric era of factor analytic research. Rather, I recommend the CHC framework serve as the stepping stone to reinvigorate the investigation of the structure of human intelligence.

Finally, the Woodcock-Muñoz Foundation Human Cognitive Abilities (HCA) project, which is an evolving, free, on-line electronic archive of the majority of datasets analyzed in Carroll's (1993) seminal treatise on factor analysis of human cognitive abilities, is introduced and described. Intelligence scholars are urged to access the Carroll HCA datasets to test and evaluate structural models of human intelligence with contemporary methods (confirmatory factor analysis). In addition, suggestions are offered for linking the analysis of contemporary data sets with the seminal work of Carroll. The emergence of a consensus CHC taxonomy and access to the original datasets analyzed by Carroll provides an unprecedented opportunity to extend and refine our understanding of human intelligence.

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<http://www.iqscorner.com/2009/11/cattell-horn-carroll-chc-theory-key.html>

So, what is Intelligence now?

Intelligence is defined not as a measurement of a single monumental ability, but rather as multidimensional construct taking into account measures of a broad array of abilities and talents.



Schneider and McGrew's Conceptualization of Gsm and Glr in Contemporary CHC Theory

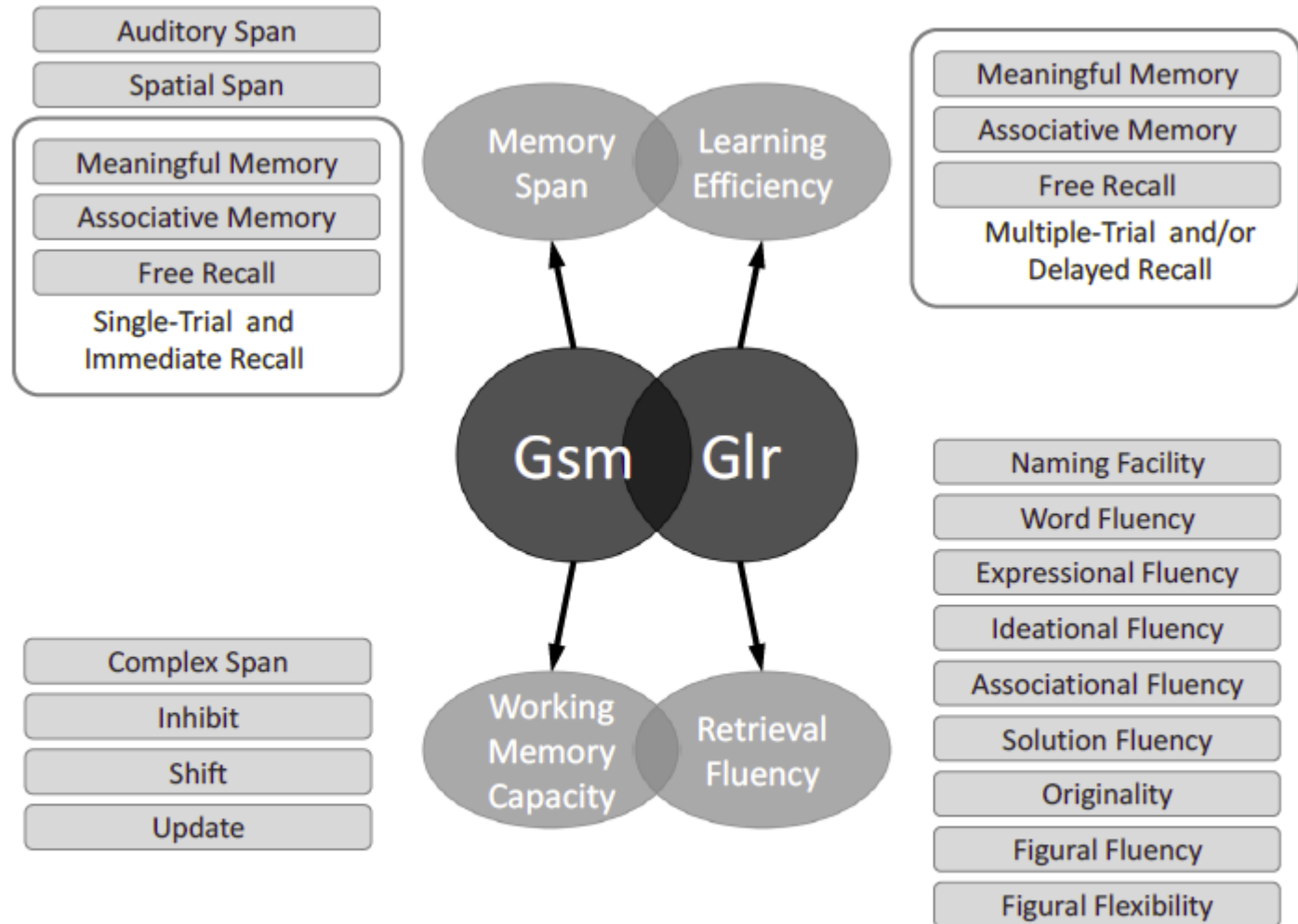
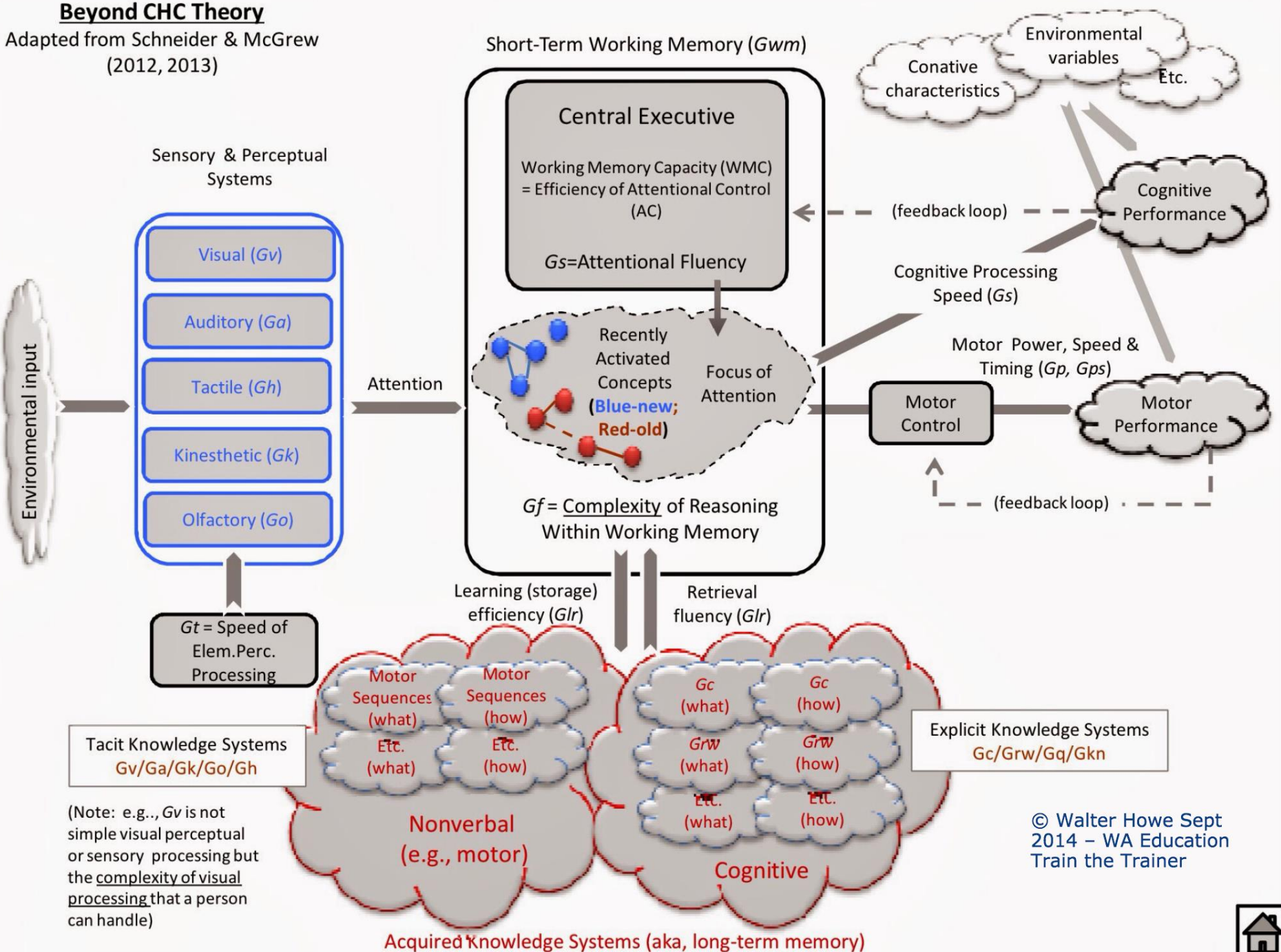


Figure 4.6. Conceptual map of memory-related abilities in CHC theory.

Beyond CHC Theory

Adapted from Schneider & McGrew
(2012, 2013)



Other Models

- The Planning, Attention-Arousal, Simultaneous and Successive (PASS) theory of intelligence;
 - Based on A.R. Luria's work and proposed in 1975 by Das, Kirby, and Jarman;
 - Elaborated on by Das, Naglieri & Kirby(1994) and Das, Kar & Parrila (1996);
 - Challenges *g*-theory on the grounds that the brain is made up of interdependent, but separate, functional systems.
- Gardner's Theory of Multiple Intelligences;
- Robert Sternberg's Triarchic Theory of Intelligence; and there are more . . .

Summary - CHC Theory

- Combination of the work of Cattell, Horn and Carroll
- Most empirically supported , psychometrically based, contemporary description of human cognitive abilities
 - Taxonomy of cognitive abilities – allows for a strength and weaknesses approach
 - Theory describes cognitive abilities as a function of degree of breadth/generalality
- Based on the analysis of hundreds of data sets that were not restricted to a particular test battery (factor analysis)
- Psychometric, developmental, neurocognitive, and heritability evidence in support of CHC theory available
- Predictive validity – measurement of achievement

**Overall
cognitive ability**
(e.g., full scale IQ)

Spearman's g
(general intelligence)

**Broad
CHC abilities**
(7 of relevance to
academic achievement
shown)

**Fluid
reasoning**
(Gf)

**Crystallised
knowledge**
(Gc)

**Visual
processing**
(Gv)

**Short-term
memory**
(Gsm)

**Long-term
storage and
retrieval**
(Glr)

**Processing
speed**
(Gs)

**Auditory
processing**
(Ga)

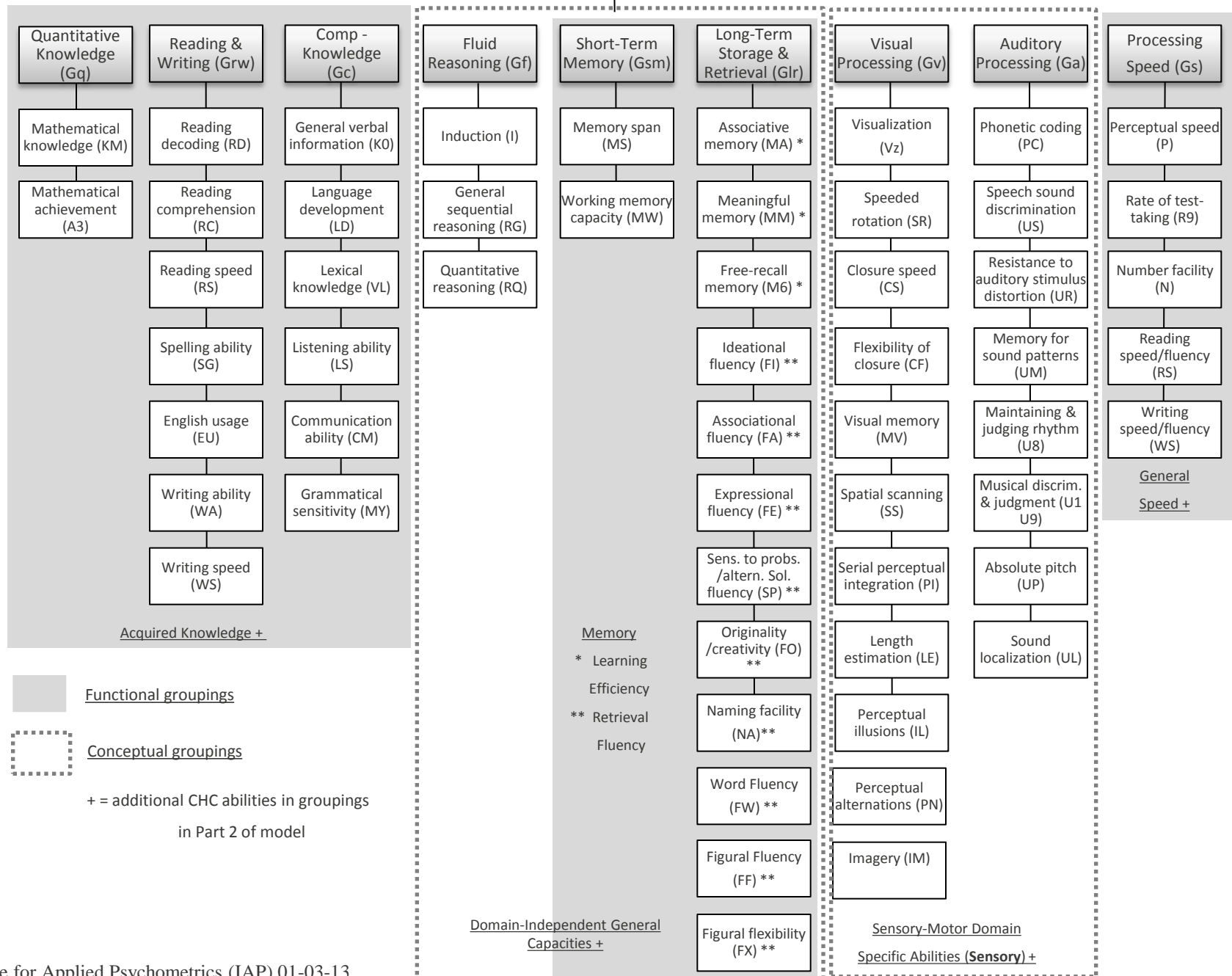
**Narrow
CHC abilities**

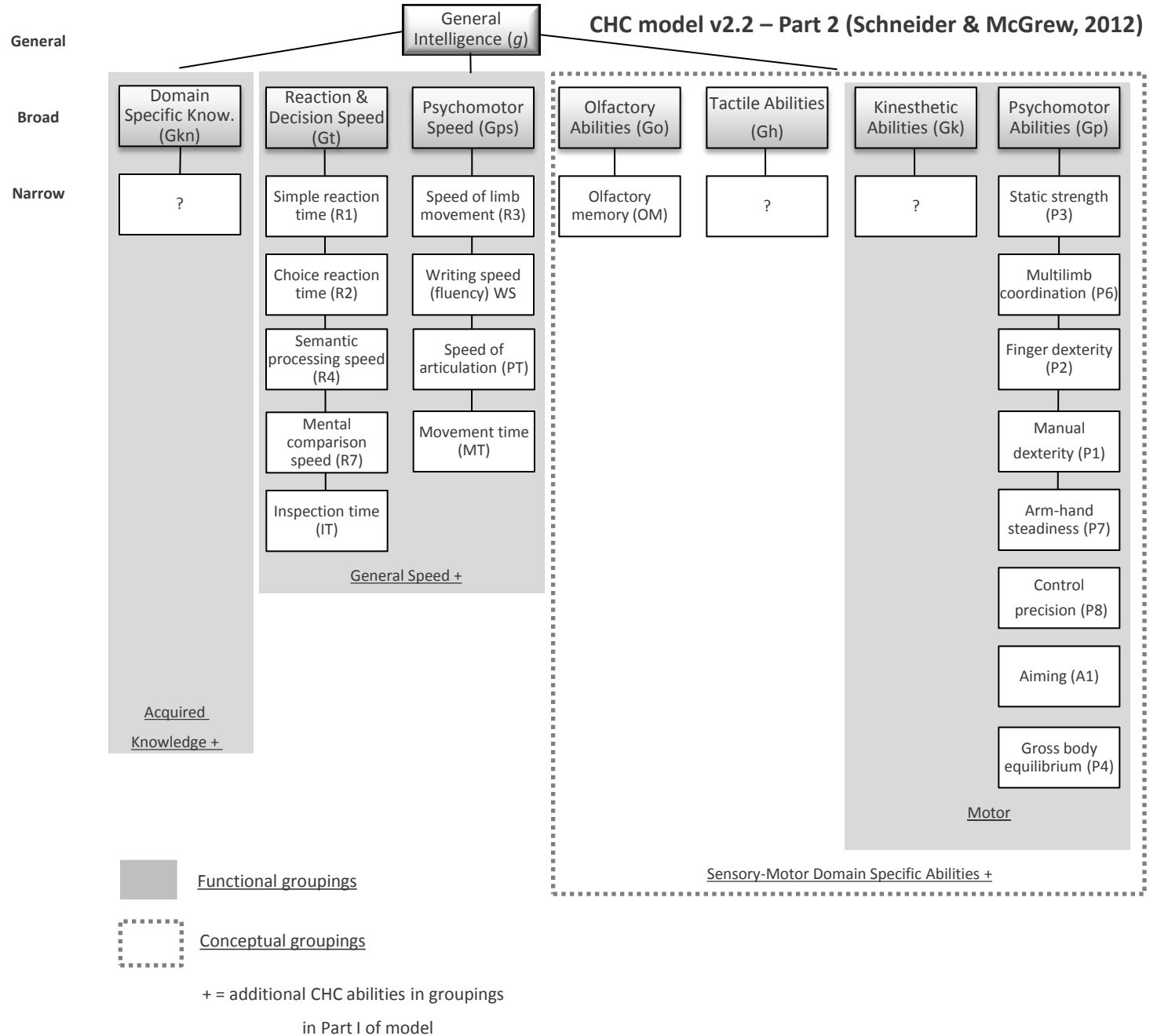
Over 70 narrow abilities (e.g., phonetic coding, associative memory, working memory)

General

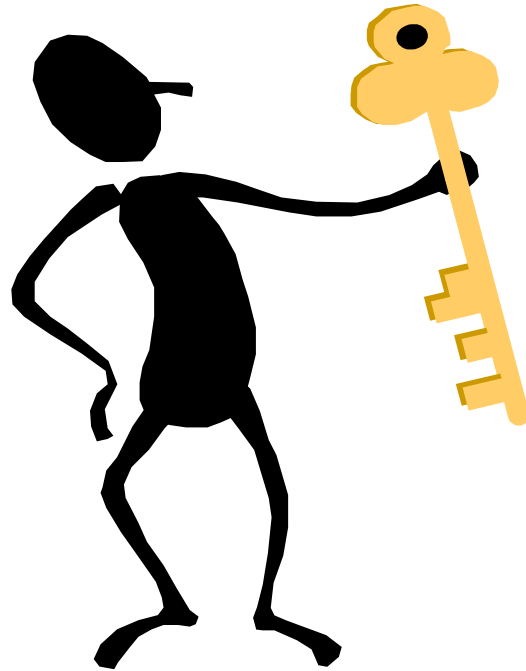
Broad

Narrow





Stratum II -The Broad Abilities



General

General Intelligence (g)

Broad

Quantitative Knowledge (Gq)

Reading & Writing (Grw)

Comp - Knowledge (Gc)

Fluid Reasoning (Gf)

Short-Term Memory (Gsm)

Long-Term Storage & Retrieval (Glr)

Visual Processing (Gv)

Auditory Processing (Ga)

Processing Speed (Gs)

Narrow

Mathematical knowledge (KM)

Reading decoding (RD)

General verbal information (KO)

Induction (I)

Memory span (MS)

Associative memory (MA) *

Visualization (Vz)

Phonetic coding (PC)

Perceptual speed (P)

Mathematical achievement (A3)

Reading comprehension (RC)

Language development (LD)

General sequential reasoning (RG)

Working memory capacity (MW)

Meaningful memory (MM) *

Speeded rotation (SR)

Speech sound discrimination (US)

Rate of test-taking (R9)

Reading speed (RS)

Lexical knowledge (VL)

Quantitative reasoning (RQ)

Free-recall memory (M6) *

Closure speed (CS)

Resistance to auditory stimulus distortion (UR)

Number facility (N)

Spelling ability (SG)

Listening ability (LS)

Ideational fluency (FI) **

Flexibility of closure (CF)

Memory for sound patterns (UM)

Reading speed/fluency (RS)

English usage (EU)

Communication ability (CM)

Associational fluency (FA) **

Visual memory (MV)

Maintaining & judging rhythm (U8)

Writing speed/fluency (WS)

Writing ability (WA)

Grammatical sensitivity (MY)

Expressional fluency (FE) **

Spatial scanning (SS)

Musical discrim. & judgment (U1 U9)

Writing speed (WS)

Sens. to probs. /altern. Sol. fluency (SP) **

Serial perceptual integration (PI)

Absolute pitch (UP)

Acquired Knowledge +Memory

* Learning
Efficiency
** Retrieval
Fluency

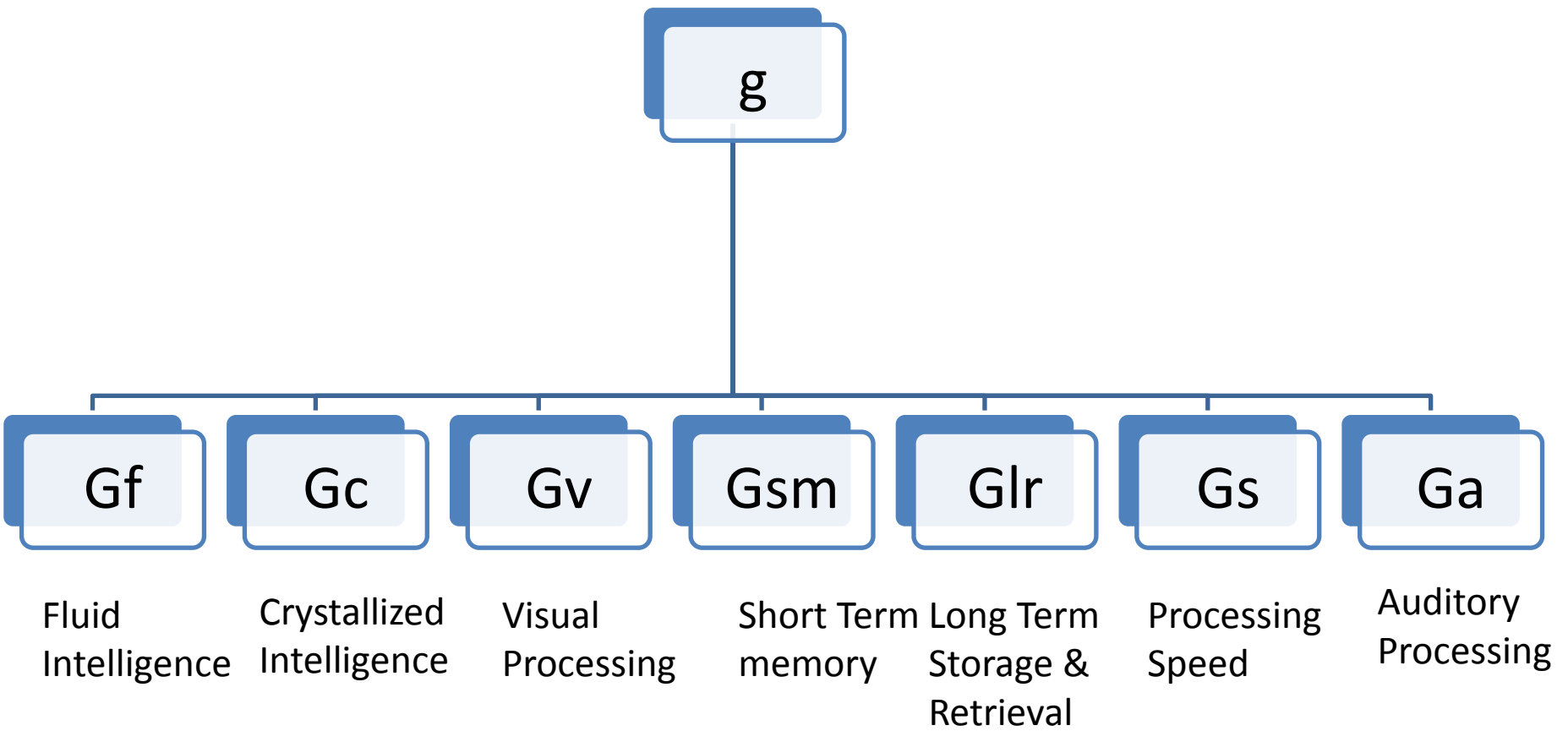
Functional groupingsConceptual groupings

+ = additional CHC abilities in groupings
in Part 2 of model

Domain-Independent General Capacities +

Sensory-Motor DomainSpecific Abilities (Sensory) +

Contemporary Assessments aim for.....



CHC Broad Ability	Definition	General Manifestations of Weaknesses	Example subtests
Fluid reasoning (Gf)	The deliberate but flexible control of attention to solve novel “on the spot” problems that cannot be performed by relying exclusively on previously learned habits, schemas, and scripts	<i>Difficulties with:</i> <ul style="list-style-type: none"> • Higher-level thinking • Transferring or generalising information • Deriving solutions for novel problems • Extending knowledge through critical thinking • Perceiving and applying underlying rules or process(es) to solve problems 	WECH Matrix Reasoning WECH Picture Concepts
Comprehension-Knowledge (Gc)	Depth and breadth of knowledge and skills that are valued by one’s culture	<i>Difficulties with:</i> <ul style="list-style-type: none"> • Vocabulary acquisition • Knowledge acquisition • Comprehending language • Fact-based/informational questions • Using prior knowledge to support learning 	WECH Vocabulary WECH Similarities WECH Information WECH Comprehension
Visual Processing (Gv)	The ability to make use of simulated mental imagery (often in conjunction with currently perceived images) to solve problems	<i>Difficulties with:</i> <ul style="list-style-type: none"> • Recognising patterns • Reading maps, graphs, and charts • Attending to fine visual detail 	WECH Block Design WECH Picture Completion
Short-term Memory (Gsm)	The ability to encode, maintain, and manipulate information in one’s immediate awareness	<i>Difficulties with:</i> <ul style="list-style-type: none"> • Following oral and written instructions • Remembering information long enough to apply it • Remembering the sequence of information • Rote memorisation 	WECH Digit Span WECH Letter-Number Sequencing

Representation of Broad CHC Abilities

	Gf	Gc	Gv	Gsm	Glr	Ga	Gs
WISC-IV	Matrix Reasoning Picture Concepts Arithmetic	Vocabulary Information Similarities Comprehension Word Reasoning	Block Design Picture Completion	Digit Span Letter-Number Sequencing Arithmetic	-	-	Symbol Search Coding Cancellation
WPPSI-IV	Matrix Reasoning	Vocabulary Information Similarities Comprehension Picture Concept Picture Naming Receptive Vocabulary	Block Design Object Assembly Picture memory Zoo Locations	-	-	-	Animal Coding Bug Search Cancellation
WPPSI-III	Matrix Reasoning Picture Concepts	Vocabulary Information Similarities Comprehension Receptive Vocabulary Picture Naming Word Reasoning	Block Design Object Assembly Picture Completion	-	-	-	Coding Symbol Search
WJ III	Concept Formation Analysis-Synthesis	Verbal Comprehension General Information	Spatial Relations Picture Recognition	Memory for Words Numbers Reversed Auditory Working Memory	Visual-Auditory Learning Retrieval Fluency Visual-Auditory Learning Delayed Rapid Picture Naming	Incomplete Words Sound Blending Sound Patterns	Visual Matching Decision Speed Pair Cancellation

Representation of Broad CHC Abilities

	Gf	Gc	Gv	Gsm	Glr	Ga	Gs
WAIS-IV	Matrix Reasoning Figure Weights	Vocabulary Information Similarities Comprehension	Block Design Picture Completion Visual Puzzles	Digit Span Letter-Number Sequencing Arithmetic	-	-	Symbol Search Coding Cancellation
WAIS-III	Matrix Reasoning	Vocabulary Information Similarities Comprehension	Block Design Object Assembly Picture Arrangement Picture Completion	Digit Span Letter-Number Sequencing	-	-	Symbol Search Digit-Symbol Coding
SB5	Nonverbal Fluid Reasoning Verbal Fluid Reasoning Nonverbal Quantitative Reasoning Verbal Quantitative Reasoning	Nonverbal Knowledge Verbal Knowledge	Nonverbal visual-spatial processing Verbal Visual-spatial processing	Nonverbal Working Memory Verbal Working memory			
Adapted from Flanagan et al, (2013)							

	Gf	Gc	Gv	Gsm	Glr	Ga	Gs
CTOPP-2				Memory for Digits Nonword Repetition	Rapid Digit Naming Rapid Letter Naming Rapid Colour/Object Naming	Elision Blending Words Phoneme Isolation Segmenting Nonwords Blending Nonwords	
PPVT-4		(VL)					
LEITER III	Classification Analogies Sequential Order		Figure Ground Form Completion Visual Patterns	<i>Forward Memory</i> <i>Reverse Memory</i>			<i>Attention Sustained</i> <i>Nonverbal Stroop</i> <i>Attention Divided</i>
UNIT	Analogic Reasoning Cube Design		Symbolic Memory Spatial Memory Object Memory	<i>Non-symbolic Quantity</i> <i>Numerical Series</i>			
	Gq	Grw					
WIAT-II	Numerical Operations	Spelling Word Reading Pseudoword Decoding Reading Comprehension					

Broad Abilities

- The aggregate of Broad Abilities provides an estimate of overall intellectual/cognitive functioning or *g*.
- It is recommended that **at least TWO SUBTESTS** be used to measure a Broad Ability, each subtest measuring a qualitatively different aspect (*Narrow Ability*) of that Broad Ability.
- The more qualitatively different aspects of the Broad Ability that are assessed, the better the measurement and estimate of the Broad Ability.
 - *Dawn P. Flanagan, Ph.D. Vincent C. Alfonso, Ph.D.*



Stratum I – The Narrow Abilities!

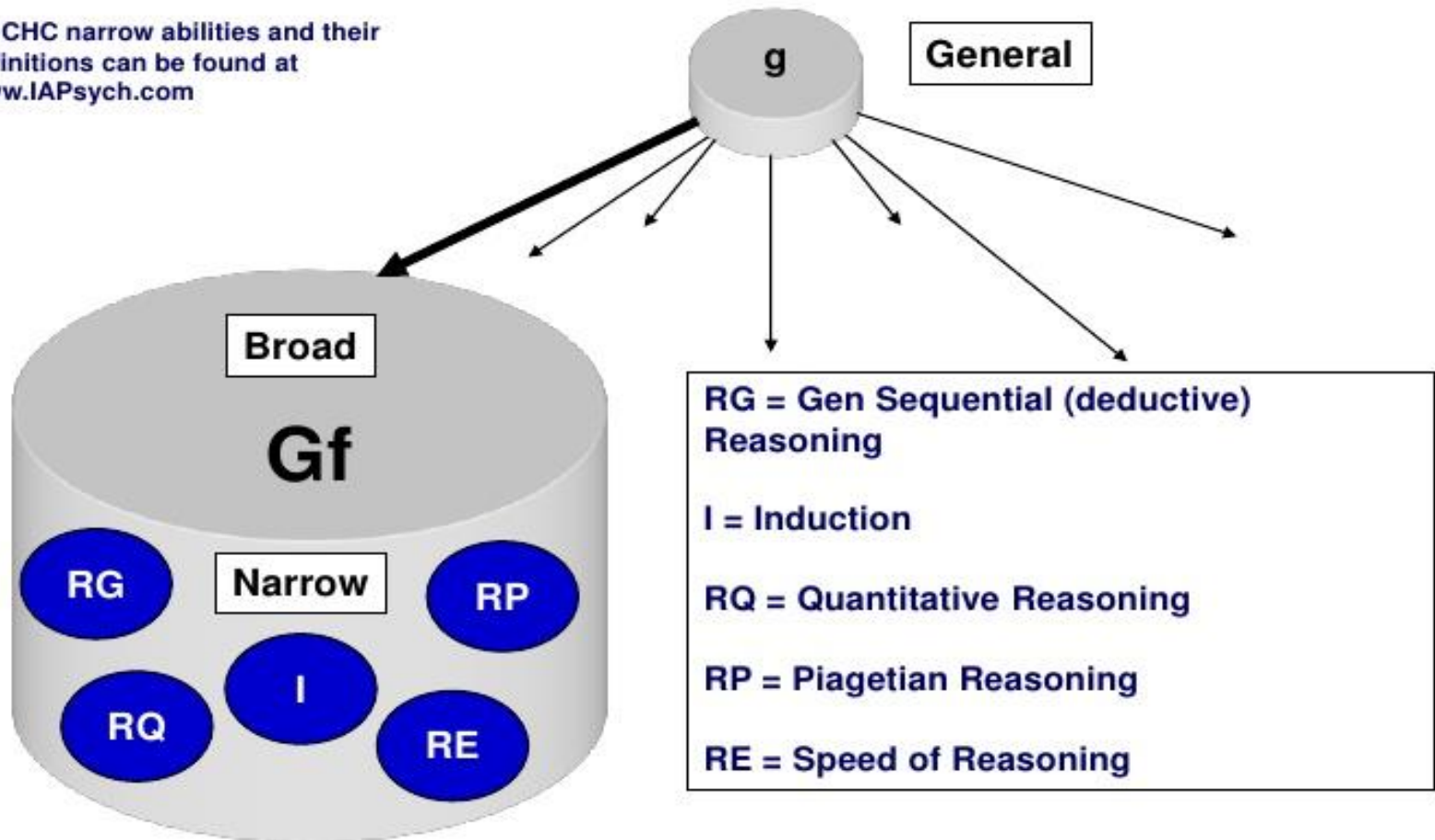




Relationship between Broad and Narrow Abilities

CHC theory classifies abilities according to three levels or strata

All CHC narrow abilities and their definitions can be found at www.IAPsych.com



Narrow Abilities

- Originally identified by Carroll through meta-analysis of 460 data sets (Carroll, 1993).
- Particular Narrow Abilities have been identified as integral to academic achievement (McGrew & Wendling, 2010).
- Factor analysis and expert collaboration has classified some 800 tests /subtests into Narrow Abilities (Flanagan et al., 2013).
- This allows selection of tests/subtests to answer referral questions.

Narrow cluster abilities

- Narrow Abilities “*represent greater specialisations of abilities, often in quite specific ways, that reflect the effects of experience and learning, or the adoption of particular strategies of performance*” (Carroll, 1993, p. 634).
- E.g. - if a child appears to have difficulty with memory, then it would be important to assess memory in-depth, via the use of multiple Narrow Ability indicators of *Gsm* and *Glr*. By focusing on a range of Narrow Abilities that make up *Gsm* and *Glr*, it is possible to identify memory difficulties more precisely.

Dawn P. Flanagan, Ph.D. Vincent C. Alfonso, Ph.D.

Narrow Abilities cont'd!

- Narrow Abilities should **also** be represented by **at least TWO SUBTESTS**.
- Most intelligence batteries do not contain multiple measures of the same Narrow Abilities (e.g., two or more tests of inductive reasoning; two or more tests of spatial relations),
- It is often necessary to cross battery in an attempt to measure Narrow Abilities adequately.

Dawn P. Flanagan, Ph.D. Vincent C. Alfonso, Ph.D.

WISC Tools



The changing FS IQ content of the WISC series: **CHC ability analysis**

WISC/WISC-R/WISC-III/WISC-IV CHC test classifications: Kevin McGrew 2-5-10

Subtests	WISC (1949)	WISC-R (1974)	WISC-III (1991)	WISC-IV (2003)
Information	Gc	Gc	Gc	Gc
Comprehension	Gc	Gc	Gc	Gc
Arithmetic	Gq/Gsm	Gq/Gsm	Gq/Gsm	Gq/Gsm
Similarities	Gc	Gc	Gc	Gc
Vocabulary	Gc	Gc	Gc	Gc
Digit Span	Gsm	Gsm	Gsm	Gsm
Letter-Number Seq.				Gsm
Word Reasoning				Gc
Picture Completion	Gv/Gc	Gv/Gc	Gv/Gc	Gv
Picture Arrangement	Gv/Gc	Gv/Gc	Gv/Gc	
Block Design	Gv	Gv	Gv	Gv
Object Assembly	Gv	Gv	Gv	
Coding	Gs	Gs	Gs	Gs
Mazes	Gv	Gv		
Symbol Search			Gs	Gs/Gv
Matrix Reasoning				Gf
Picture Concepts				Gf
Cancellation				Gs

Higher Order, Multisample, Confirmatory Factor Analysis of the Wechsler Intelligence Scale for Children—Fourth Edition: What Does It Measure?

Timothy Z. Keith and Jodene Goldenring Fine
The University of Texas

Gordon E. Taub
University of Central Florida

Matthew R. Reynolds
The University of Texas

John H. Kranzler
University of Florida

- This article shows factor analysis of the WISC IV subtests (identified as yielding four factors : VCI, PRI WMI & PSI)
- CFA confirmed that the WISC IV in fact yielded five factors not four : PRI was found to be a combination of Gf and Gv clusters.

Test Construct Irrelevance!

- PRI has been found to be a measure of Gf and Gv (Keith et al., 2006).
- The PRI of the WISC IV demonstrates **construct irrelevance** in terms of CHC theory of intelligence.
- This means that the assessment is too broad a measure of a specific CHC construct (Broad Ability in this case).

Test construct under-representation!

Battery	Gf	Gc	Gv	Gsm	Glr	Ga	Gs
WISC-IV	Picture Concepts (I) Matrix reasoning (I)	Vocabulary (VL) Similarities (VL, : Gf (I) Comprehension (Ko) Information (K0)	Block Design (Vz) Picture Completion (CF, Gc : KO)	Digit Span (MS, MW) Letter-Number Sequencing (MW)			Coding (R9) Symbol Search (P,)

WISC IV and its Narrow Abilities -

- Where a CHC Broad Ability is represented by **ONLY ONE** Narrow Ability the assessment is **too narrow** to represent the cluster adequately

Adapted from Flanagan et al, (2013)

Why is Gf under-represented in the WISC IV?

- Picture Concepts and Matrix Reasoning **BOTH** measure the Narrow Ability – *Induction*- the ability to observe and infer rules or principles.
- The Narrow Ability of *Induction* is well measured therefore; however
- An adequate measure of the Broad Ability Gf requires measurement of at least **TWO DIFFERENT** Narrow Abilities
- Therefore not a good measure of Gf!

Adapted from Flanagan et al, (2013)

Other Issues: Subtest Level

- Arithmetic subtest is a complex measure of cognitive abilities;
 - measures primarily Gf (via Narrow Ability RQ)
 - found to load “similarly” on Broad Abilities Gq (A3) and Gsm (MW).
 - may also measure verbal comprehension and knowledge in Gc (Broad Ability).
- However Arithmetic appears to be a good, strong, stable measure of ***g***

Other findings:



- Matrix Reasoning - loads to Gf and Gv
- Picture Completion - loads to Gv and Gc
- Symbol Search – loads to Gs and Gv
- Similarities – loads to Gc (VL) and Gf (I)

REF: Keith, T.Z., Fine, J.C., Taub G.E., Reynolds M.R., and Kranzler, J.H. (2006). Higher Order, Multisample, Confirmatory Factor Analysis of the Wechsler Intelligence Scale for Children - Fourth Edition: What Does It Measure? *School Psychology Review*, 35, 108—127

Overall Findings:

- The FSIQ score is likely the best estimate of ***g*** (although it doesn't generally include Arithmetic!)
- Users of the test can interpret confidently the subtest from the VCI as measuring the Broad Ability area of Gc.
- The three subtests from the PSI appear to measure a coherent factor, likely Gs.
- The WMI is a mix of working memory capacity and memory span, therefore the Board Ability area of Gsm.

REF: Keith, T.Z., Fine, J.C., Taub G.E., Reynolds M.R., and Kranzler, J.H. (2006). Higher Order, Multisample, Confirmatory Factor Analysis of the Wechsler Intelligence Scale for Children - Fourth Edition: What Does It Measure? *School Psychology Review*, 35, 108—127

The WISC-V



REF:

<http://www.pearsonclinical.com/psychology/products/100000771/wechsler-intelligence-scale-for-childrensupsupfifth-edition--wisc-v.html#tab-faq>

WISC-V

Theoretical Foundations

- Numerous structural models of intelligence
 - Wechsler considers various models (one of which is Cattell-Horn-Carroll [CHC])
 - Example: An expansion of Vernon's hierarchical model produces superior CFA results in some studies (Johnson & Bouchard, 2005a; 2005b; Johnson, te Nijenhuis, & Bouchard, 2007)
- Wechsler model accounts for important aspects of cognitive ability that these models converge upon
- CHC theory is still evolving
- CHC theory does not account for important lessons we learn from working memory models (Multicomponent model, Baddeley, 2000, 2002, 2012; Embedded-processes model, Cowan, 1988; Towse & Cowan, 2005)
- Neurodevelopmental models
- Clinical utility (#1)

REF: http://www.cde.state.co.us/cdesped/mh_wisc-v

WISC-V

Full Scale

Verbal Comprehension	Visual Spatial	Fluid Reasoning	Working Memory	Processing Speed
Similarities	Block Design	Matrix Reasoning	Digit Span	Coding
Vocabulary	Visual Puzzles	Figure Weights	Picture Span	Symbol Search
Information		Picture Concepts	Letter-Number Sequencing	Cancellation
Comprehension		Arithmetic		

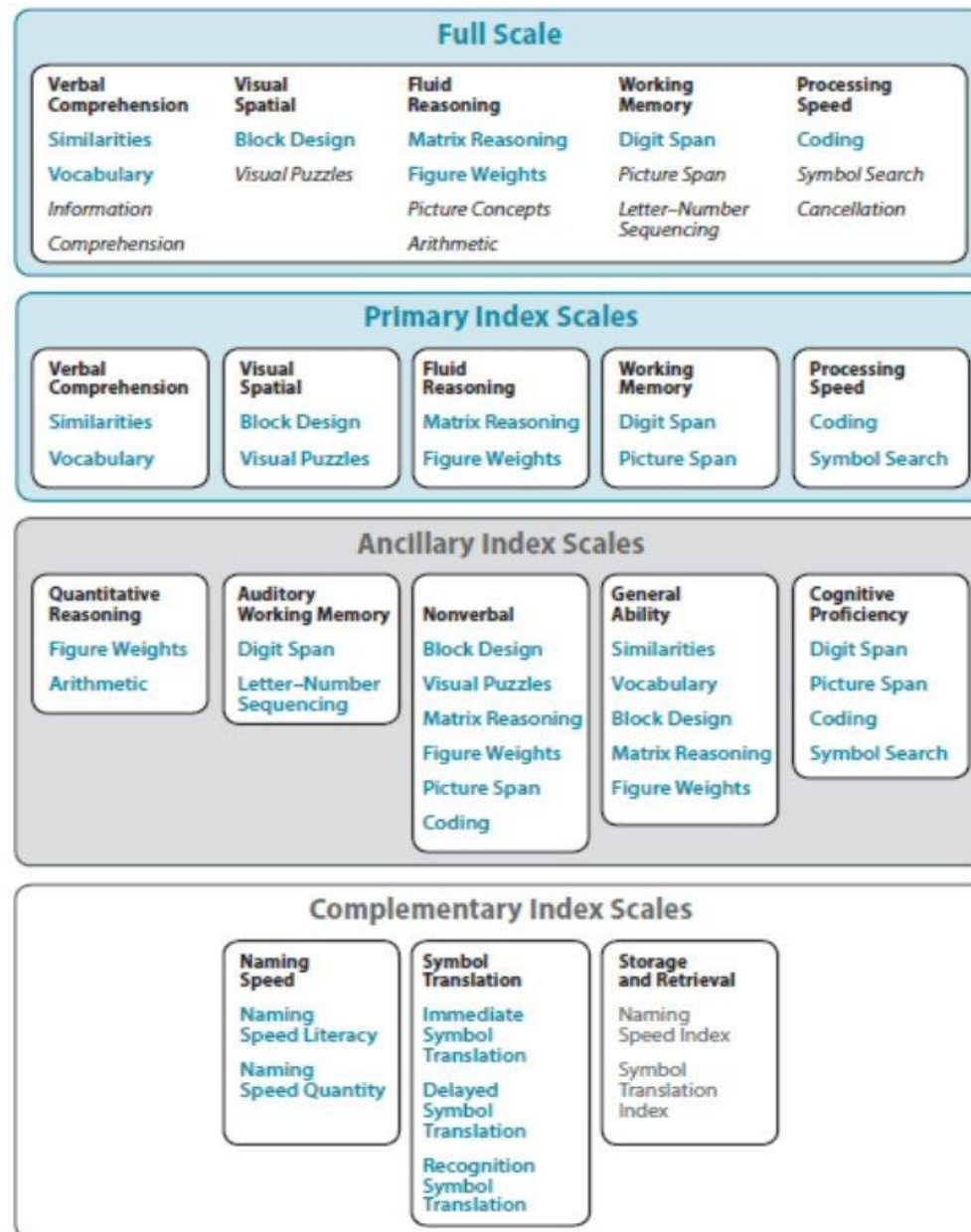
Why Wechsler FSIQ?



- Cognitive functions are interrelated
- Cognitive tasks rarely performed in isolation
 - Subtests require the use of multiple cognitive abilities

*Theory has evolved to now include a greater
focus on primary scale interpretation*

WISC V Framework



	Gf	Gc	Gv	Gsm	Glr	Ga	Gs
WISC-IV	Matrix Reasoning (I) Picture Concepts (I; <i>Gc:LS; KO</i>)	Vocabulary (VL) Information (KO) Similarities (VL; <i>Gf:I</i>) Comprehension (KO) Word Reasoning (VL; <i>Gf:I</i>)	Block Design (VZ) Picture Completion (CF; <i>Gc:KO</i>)	Digit Span (MS; MW) Letter Number Sequencing (MW) Arithmetic (MW; <i>Gf:RQ</i>)	-	-	Symbol Search (P) Coding (R9) Cancellation (P)
WISC-V	Matrix Reasoning (I) Picture Concepts (I; <i>Gc:LS; KO</i>) Figure Weights (RQ) Arithmetic (RQ; <i>Gsm:MW; Gc:?</i>)	Vocabulary (VL) Information (LS; KO) Similarities (VL; <i>Gf:I</i>) Comprehension (LS; KO)	Block Design (VZ) Visual Puzzles (VZ)	Digit Span (MS; MW) Letter Number Sequencing (MW) Picture Span (MW; <i>Gv:MV</i>)	Immediate Symbol Translation (MA) Delayed Symbol Translation (MA) Recognition Symbol Translation (MA) Naming Speed Literacy (NA; <i>Gs:R9</i>) Naming Speed Quantity (NA; <i>Gs:R9</i>)		Coding (R9) Symbol Search (P) Cancellation (P)

Some general terms to remember

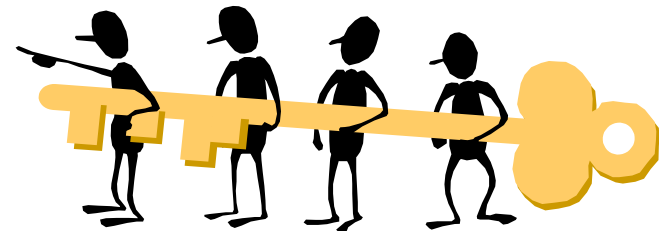
- **Construct irrelevance**
whereby a composite is represented by MORE than ONE CHC ability-assessment is **too broad** with variance due to distinct alternate Broad Abilities
- **Construct underrepresentation**
whereby a CHC Broad Ability is represented by ONLY ONE Narrow Ability- assessment is **too narrow** to represent the Broad Ability adequately

Therefore...

- Construct irrelevance:
ensure test/subtests are
a pure measure of ONE
Broad Ability only
- Construct
underrepresentation:
ensure that each Broad
Ability measured has at
least TWO qualitatively
different Narrow
Abilities

So.....to recap.....

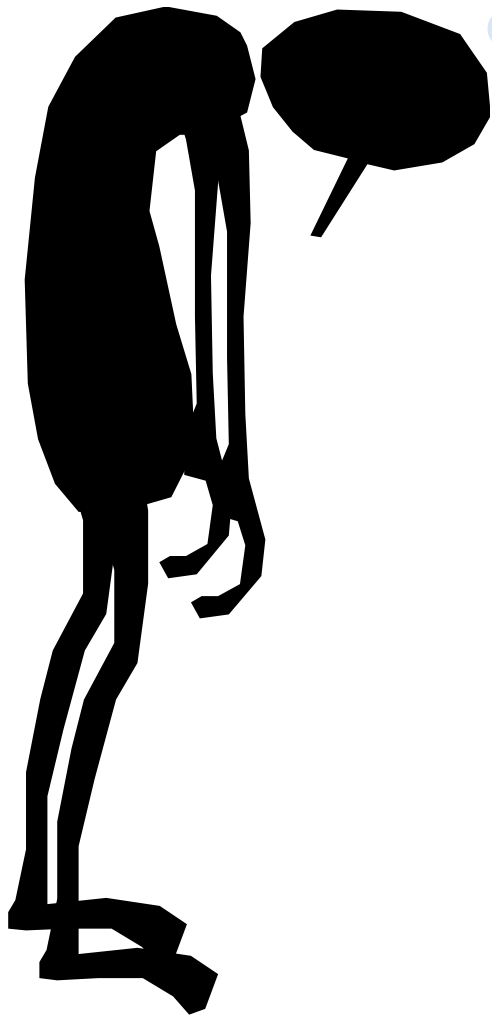
- CHC is an empirically validated three strata model
- Emphasis is less on g (Stratum III) and more on Broad Abilities (Stratum II)
- Further research indicates that MORE SPECIFICALLY Stratum I Narrow Abilities hold the key to exploring the cognitive-achievement interface.





Stratum I & Learning

- Specific Narrow Abilities have been implicated in reading, writing and numeracy acquisition.
- The KEY relationships between cognitive abilities and achievement abilities lay in the **Narrow Abilities.**



SO ..a **comprehensive
CHC assessment** cannot
be done with most
batteries?

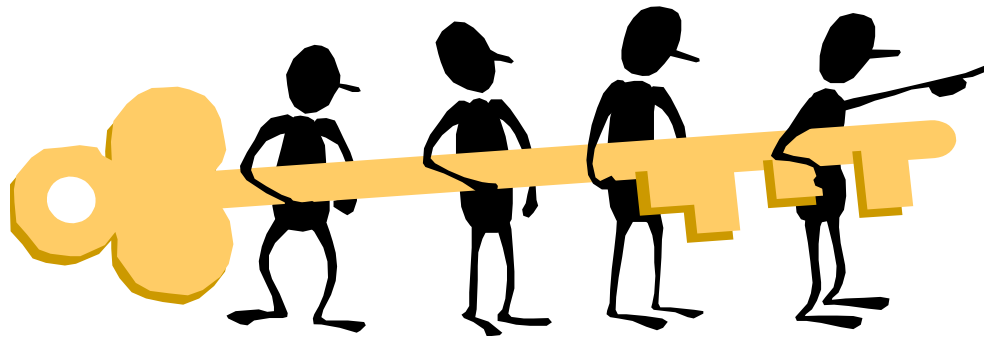
what the hell is that?



oh,
just my mind

CROSS-BATTERY ASSESSMENT (XBA)

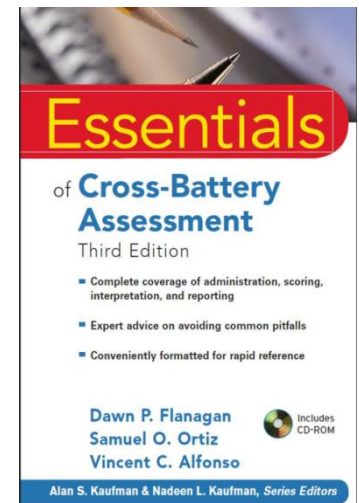
The Basics



CHC XBA:

Is a procedure developed by which non CHC batteries or those with weak CHC representability (Wechsler scales) could be interpreted via the CHC view of cognitive abilities (McGrew, 2009)

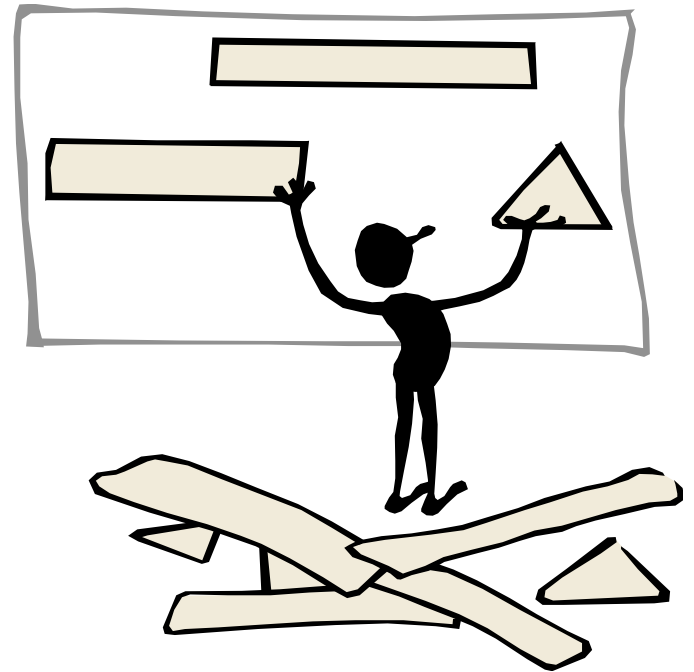
Allows practitioners to validly measure a wider range or a more in-depth BUT selected range of abilities. Done in a manner consistent with contemporary psychometric theory and current intelligence research (Flanagan, Ortiz & McGrew, 2007)



The Three Pillars of XBA

- CHC Theory
- Broad Abilities
- Narrow Abilities

To apply XBA, practitioners need to understand how Broad and Narrow CHC abilities relate to the reason(s) for and purpose(s) of the referral.



Broad v. Narrow

- **Broad Abilities** are more overarching mental capacities and weaknesses at this level place constraints on learning and achievement
- **Narrow Abilities** and processes are more specific mental capacities. Weaknesses in Narrow Abilities may be remediated, compensated for, or accommodated – all of which can serve to limit their adverse affects on learning and achievement

Broad and Narrow Abilities

- In general, measurement of Broad Abilities is done when the purpose of an evaluation is to examine the breadth of broad cognitive constructs that define overall intellectual/ cognitive functioning or *g* within the psychometric (CHC) tradition.
- This allows selection of tests/subtests to answer referral questions
- Particular narrow abilities have been identified as integral to academic achievement (McGrew & Wendling, 2010).



ACTIVITY!!



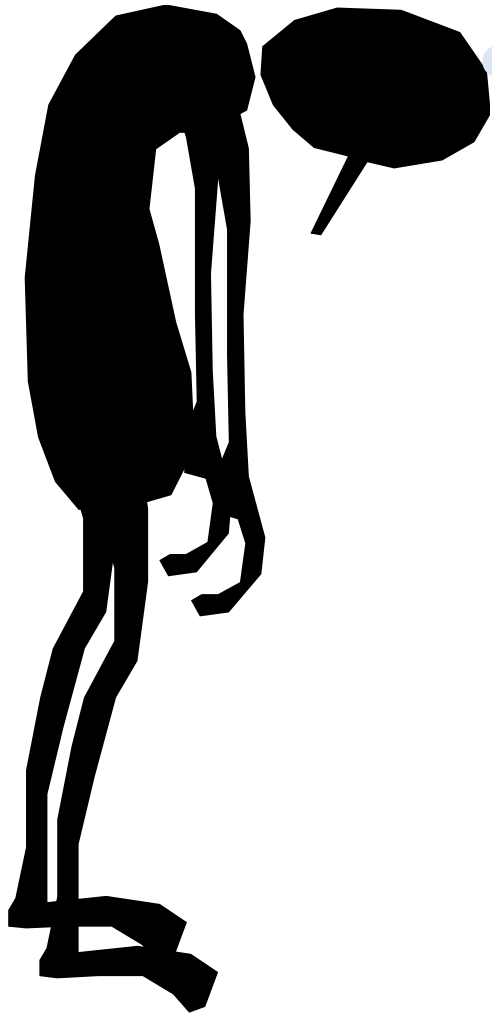
- What does CHC using the WISC-IV tell us about this student? Plot . . .
 - Referral question: Why is this student making limited progress in literacy and struggling to retain learnt material?
 - 9 Year old male in Year 4
 - Unremarkable history – no Speech or OT, no significant medical issues
 - Regular attendance and stable schooling

Index	Standard Scores
Verbal Comprehension	85
Perceptual Reasoning	98
Working Memory	80
Processing Speed	85
FULL-SCALE SCORE	84

Scale	Sub-test	Scaled Scores
Verbal Comprehension	Similarities (Gc:VL)	8
	Vocabulary (Gc:VL)	7
	Comprehension (Gc:KO)	7
Perceptual Reasoning Gv	Block Design (Gv:VZ)	4
	Picture Concepts (Gf:I)	8
	Matrix Reasoning (Gf:I)	12
Working Memory	Digit Span (Gsm:MS, MW)	7
	Letter-Number Sequencing (Gsm:MW)	6
Processing Speed	Coding (Gs:R9)	7
	Symbol Search (Gs:P)	8

Case Study

Gc	Gf	Gsm	Glr	Gv	Ga	Gs
<div>LEXICAL KNOWLEDGE (VL)</div> <div>Vocabulary7</div> <div>Similarities8</div> <div>General Verbal Information (KO)</div> <div>Comprehension7</div>	<div>INDUCTION (I)</div> <div>Matrix Reasoning12</div> <div>Picture Concepts8</div>	<div>MEMORY SPAN (MS)</div> <div>Digit Span7</div> <div>WORKING MEMORY (MW)</div> <div>Letter-Number Sequencing6</div>	-	<div>VISUALIZATION (Vz)</div> <div>Block Design4</div>	-	<div>PERCEPTUAL SPEED (P)</div> <div>Symbol Search8</div> <div>RATE OF TEST TAKING (R9)</div> <div>Coding7</div>



Can not answer the
referral question with
these results so far. SO
to cross-battery . . .

Guiding Principles

- These are the steps to follow a sound XBA

Battery selection

- Select the battery that BEST answers the referral question

Norm clusters

- This difficult with WISC IV as not developed as CHC test.

Select tests

- This should not be done ad hoc but with acceptable plan

Under-represented?

- When broad cluster underrepresented obtain from other battery

Similar norms

- When crossing batteries , select tests that are normed and developed within a similar time frame

Number of tests?

- Select tests from the smallest possible number of batteries to reduce error

Appendix B

CHC Broad and Narrow Ability Classification Tables for Tests Published Between 2001 and 2012

- Tests printed in **BOLD, UPPERCASE LETTERS** are measures of the abilities as defined empirically via factor analysis.
- Tests printed in **bold, lowercase letters** are mixed measures of the abilities as defined empirically via factor analysis.
- Tests printed in REGULAR FACE, UPPERCASE LETTERS are measures of the abilities as classified empirically via an expert consensus process.
- Tests printed in regular face, lowercase letters are mixed measures of the abilities as classified empirically via an expert consensus process.

*Tests marked with an asterisk have a secondary Broad and Narrow ability classification via an expert consensus process over and above its primary classification as derived from factor analysis (see Table B.1 for results).

Case Study

Gc	Gf	Gsm	Glr	Gv	Ga	Gs
<div>LEXICAL KNOWLEDGE (VL)</div> <div>Vocabulary 7</div> <div>Similarities 8</div> <div>General Verbal Information (KO)</div> <div>Comprehension 7</div>	<div>INDUCTION (I)</div> <div>Matrix Reasoning 12</div> <div>Picture Concepts 8</div> <div>QUANTITATIVE REASONING (RQ)</div> <div>Arithmetic</div> <div>WIAT-II: Maths Reasoning</div>	<div>MEMORY SPAN (MS)</div> <div>Digit Span 7</div> <div>WORKING MEMORY (MW)</div> <div>Letter-Number Sequencing 6</div>	<div>NAMING FACILITY (NA)</div> <div>CTOPP: Rapid Digit Naming</div> <div>CTOPP: Rapid Letter Naming</div>	<div>VISUALIZATION (Vz)</div> <div>Block Design 4</div> <div>FLEXIBILITY OF CLOSURE (CF)</div> <div>Picture Completion</div>	<div>PHONETIC CODING (PC)</div> <div>CTOPP: Elision</div> <div>CTOPP: Blending Words</div>	<div>PERCEPTUAL SPEED (P)</div> <div>Symbol Search 8</div> <div>RATE OF TEST TAKING (R9)</div> <div>Coding 7</div>

	Gf	Gc	Gv	Gsm	Glr	Ga	Gs
WISC-IV	Matrix Reasoning (I) Picture Concepts (I; Gc:LS; KO)	Vocabulary (VL) Information (KO) Similarities (VL; Gf:I) Comprehension (KO) Word Reasoning (VL; Gf:I)	Block Design (VZ) Picture Completion (CF; Gc:KO)	Digit Span (MS; MW) Letter Number Sequencing (MW) Arithmetic (MW; Gf:RQ)	-	-	Symbol Search (P) Coding (R9) Cancellation (P)
CTOPP				Memory for Digits (Gsm:MS) Nonword Repetition (Gsm:MS)	Rapid Digit Naming (Glr:NA) Rapid Letter Naming (Glr:NA)	Elision (PC:A) Blending Words (PC:S) Segmenting Nonwords (PC:A) Blending Nonwords (PC:S)	
	Gf	Gq	Grw				
WIAT-II	Maths Reasoning (Gf:RQ)	Numerical Operations (Gq:A3)	Spelling (Grw:SG) Word Reading (Grw:RD) Pseudoword Decoding (Grw:RD) Reading Comprehension (Grw:RC)				

Common Tools and Narrow CHC Abilities?

	Gf	Gc	Gv	Gsm	Glr	Ga	Gs
WISC-IV	Matrix Reasoning (I) - 12 Picture Concepts (I; Gc:LS; KO) - 8 Arithmetic (RQ; Gsm:MW)	Vocabulary (VL) - 7 Similarities (VL; Gf:I) - 8 Comprehension (KO) - 7	Block Design (VZ) - 4 Picture Completion (CF)	Digit Span (MS; MW) - 7 Letter Number Sequencing (MW) - 6	-	-	Symbol Search (P) - 8 Coding (R9) - 7
CTOPP				Memory for Digits (MS) - 7 Nonword Repetition (MS) - 8	Rapid Digit Naming (NA) - 5 Rapid Letter Naming (NA) - 6	Elision (PC:A) - 7 Blending Words (PC:S) - 12	
	Gf	Gq	Grw				
WIAT-II	Math Reasoning (RQ) - 90	Numerical Operations (A3) - 97	Spelling (SG) - 76 Word Reading (RD) - 68 Pseudoword Decoding (RD) - 77 Reading Comprehension (RC) - 69				

Demographic Information:

Step 1. Enter examinee's name, date of evaluation, and date of birth in the boxes outlined in red below.

Name of Examinee:	Michael A	*Date of Evaluation:	8/05/2014
Name of Evaluator:	M Smith	*Date of Birth:	14/03/2005
Examinee's Age:	9 years 1 month(s)	*required information	mm/dd/yyyy

Step 2. Below is an Index of the tabs included in the program. Click on your selection to go to that tab.

COGNITIVE BATTERIES:

WISC-IV	WJ III NU COG
WAIS-IV	SB5
WPPSI-IV	DAS-II
WPPSI-III	KABC-II

ACHIEVEMENT BATTERIES:

WJ III NU ACH
WIAT-III
KTEA-II

CHC ANALYSIS:

CHC Analyzer
CHC Graph

COGNITIVE+ACHIEVEMENT GRAPHS:

WISC-IV (and WIAT-III)	WJ III NU (COG and ACH)
WAIS-IV (and WIAT-III)	SB5 (and WJ III NU ACH)
WPPSI-IV (and WIAT-III)	DAS-II (and WIAT-III)
WPPSI-III (WIAT-III)	KABC-II (and KTEA-II)

OTHER TABS:

Introduction
Notes
CHC Test Reference List
Save Data/File As...

Clear demographic data by clicking button at the right (this will clear name and dates only).

CLEAR NAME/DATE ONLY

CRYSTALLIZED INTELLIGENCE (Gc)	Enter scores below	Converted Standard Score	Composite Score Analyses
WISC-IV Similarities (Gc:VL;Gf:I)	8	90	A
WISC-IV Vocabulary (Gc:VL)	7	85	A
WISC-IV Comprehension (Gc:KO)	7	85	A
		Comp A	Comp B
Clear Gc Data		Composite Standard Score(s):	84
		Composite Percentile Rank(s):	14

Score configuration and interpretation:

The difference between the highest and lowest scores that comprise the composite is less than 1SD, therefore, the composite is considered cohesive. The composite is likely a good summary of the set of theoretically related abilities that comprise it. Interpret the composite as an adequate estimate of the ability that it is intended to measure.

LONG-TERM STORAGE AND RETRIEVAL (Glr)	Enter scores below	Converted Standard Score	Composite Score Analyses
CTOPP - Rapid Digit Naming (Glr: NA)	5	75	A
CTOPP - Rapid Letter Naming (Glr:NA)	6	80	A
		Comp A	Comp B
Clear Glr Data		Composite Standard Score(s):	74
		Composite Percentile Rank(s):	4

Score configuration and interpretation:

The difference between the scores that comprise the composite is less than 1SD and, therefore, the composite is considered cohesive. The composite is likely a good summary of the set of theoretically related abilities that comprise it. Interpret the composite as an adequate estimate of the ability that it is intended to measure.

FLUID REASONING (Gf)	Enter scores below	Converted Standard Score	Composite Score Analyses
WISC-IV Picture Concepts (Gf:I)	8	90	--
WISC-IV Matrix Reasoning (Gf:I)	12	110	--
WIAT-III Math Problem Solving (Gf:RQ)			
		Comp A	Comp B
Clear Gf Data		Composite Standard Score(s):	None
		Composite Percentile Rank(s):	

Score configuration and interpretation:

The scores that comprise the composite differ from one another by at least 1SD and may fall in different ability ranges. Therefore, the composite is not considered cohesive. As such, the composite is not likely to be a good summary of the theoretically related abilities it is intended to represent. (Note: ability ranges include - Well Below Average: <80; Below Average: 80-89; Average: 90-109; Above Average: 110-119, Well Above Average: 120-129, etc.)

SHORT-TERM MEMORY (Gsm)	Enter scores below	Converted Standard Score	Composite Score Analyses
WISC-IV Digit Span (Gsm:MS,MW)	7	85	A
WISC-IV Letter-Number Sequencing (Gsm:MW)	6	80	A
CTOPP - Non-word Repetition (Gsm:MS)	8	90	A
CTOPP - Memory for Digits (Gsm:MS)	7	85	A
		Comp A	Comp B
Clear Gsm Data		Composite Standard Score(s):	80
		Composite Percentile Rank(s):	9

Score configuration and interpretation:

The difference between the highest and lowest scores that comprise the composite is less than or equal to 1 and 1/3 SD and, therefore, the composite is considered cohesive. The composite is likely a good summary of the set of theoretically related abilities that comprise it. Interpret the composite as an adequate estimate of the ability that it is intended to measure.

Cohesive - important concept

A Broad Ability is cohesive and some confidence can be held in its interpretation if:

1. Two or more qualitatively different Narrow Abilities are present.
2. They are not statistically significantly different (XBA definition- less than 1 SD difference).
3. However when a Broad Ability is represented by two or more Narrow Abilities that are significantly different (≥ 1 SD), it is not possible to interpret this cluster with any confidence.



Rapid Reference 2.5. Representation of Broad CHC Abilities on Selected Cognitive, Academic, and Neuropsychological Batteries (Flanagan, Ortiz, & Alfonso, 2013)

Battery	<u>Gf</u>	<u>Gc</u>	<u>Gv</u>	<u>Gsm</u>	<u>Glr</u>	<u>Ga</u>	<u>Gs</u>	<u>Grw</u>	<u>Gq</u>	<u>Gkn</u>
WISC-IV	U	✓	✓	✓	--	--	✓	--	--	--
WAIS-IV	✓	✓	✓	✓	--	--	✓	--	--	--
WPPSI-IV	U	✓	✓	✓	--	--	✓	--	--	--
WJ III/NU COG	✓	✓	✓	✓	✓	✓	U	--	--	--
SB5	✓	✓	U	✓	--	--	--	--	--	--
DAS-II	✓	✓	✓	✓	✓	U	U	--	--	--
KABC-II	✓	✓	✓	U	U	--	--	--	--	--
KTEA-II	--	✓	--	--	✓	U	U	✓	U	--
WIAT-III	U	✓	--	--	U	U	U	✓	U	--
WJ III/NU ACH	U	✓	--	--	U	U	U	✓	✓	--
NEPSY-II	U	✓	✓	✓	✓	U	U	--	--	U
D-KEFS	✓	U	U	U	✓	--	✓	--	--	--
DWNB	--	U	U	U	--	--	--	--	--	--

Note: “✓” = adequate representation; “U” = underrepresented; “--” = not measured. The broad CHC abilities not included in this rapid reference (i.e., Olfactory Abilities [Go], Psychomotor Abilities [Gps], Reaction and Decision Speed [Gt], and Kinesthetic Abilities [Gk]). Gf = Fluid Reasoning; Gc = Crystalline Knowledge; Gv = Visual Processing; Gsm = Short-term Memory; Glr = Long-term Memory and Retrieval; Ga = Auditory Processing; Grw = Reading and Writing; Gq = Quantitative Knowledge; Gkn = Kinesthetic Abilities.

Criticisms of XBA



- Not always practical
- Tests are expensive and not all practitioners have access to multiple test batteries
- Only some subtests are administered
- Tests may have been normed at different times
- Different subtests with same names measure different tasks & vice versa
- There are no norms for the cross-battery mean
- It relies mainly on subtest analysis

APS Ethics guidelines for psychological assessments and the use of psychological tests

3.4. *Psychologists exercise caution in drawing inferences from psychological assessments which are:*

- *in the process of development;- NO problem here*
- *being applied outside their empirically established purposes or populations – YES this is an issue to consider*
- *used informally to generate hypotheses – not informal use, quite a structured , empirically supported practice.*
- *When such instruments are the best available, these **features are mentioned** in any formal report and taken into account in the assessment.-acknowledge XBA process when reporting.*

Acknowledge XBA approach

The results presented in this report were compiled from tests that do not share a common norm group; however, test results have been interpreted following the cross-battery approach and integrated with data from other sources including educational records, parent/teacher interviews, behavioral observations, work samples, and other test findings ***to ensure ecological validity***.

Standardisation was followed for all test administrations. No single test or procedure was used as the sole criterion for classification, eligibility or educational planning. Unless otherwise noted, the results of this evaluation are considered a reliable and valid estimate of [Student's Name] demonstrated skills and abilities at this time.

Dawn P. Flanagan, Ph.D. Vincent C. Alfonso, Ph.D.

The end for now...



Index	Standard Scores
Verbal Comprehension	83
Perceptual Reasoning	88
Working Memory	80
Processing Speed	109
FULL-SCALE SCORE	-

Case Study

Gc	Gf	Gsm	Glr	Gv	Ga	Gs
LEXICAL KNOWLEDGE (VL) Vocabulary 6 Similarities 6 Word Reasoning 9 General Verbal Information (KO) Comprehension 9 Information 9	INDUCTION (I) Matrix Reasoning 9 Picture Concepts 7 Quantitative Reasoning (RQ) Arithmetic 7	MEMORY SPAN (MS) Digit Span 7 WORKING MEMORY (MW) Letter-Number Sequencing 6 Arithmetic 7	-	VISUALIZATION (Vz) Block Design 8 Flexibility of Closure (CF) Picture Completion 11	-	PERCEPTUAL SPEED (P) Symbol Search 11 Cancellation 12 RATE OF TEST TAKING (R9) Coding -